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[1] *No. 1, 1902, Biological Laboratory.*—Preliminary Report of the Appearance in the Philippine Islands of a Disease Clinically Resembling Glanders. By R. P. Strong, M. D.

No. 2, 1902, Chemical Laboratory.—The Preparation of Benzoyl-Acetyl Peroxide and Its Use as an Intestinal Antiseptic in Cholera and Dysentery. Preliminary Notes. By Paul C. Freer, M. D., Ph. D.

[1] *No. 3, 1903, Biological Laboratory.*—A Preliminary Report on Trypanosomiasis of Horses in the Philippine Islands. By W. E. Musgrave, M. D., and Norman E. Williamson.

[1] *No. 4, 1903, Serum Laboratory.*—Preliminary Report on the Study of Rinderpest of Cattle and Carabaos in the Philippine Islands. By James W. Jobling, M. D.

[1] *No. 5, 1903, Biological Laboratory.*—Trypanosoma and Trypanosomiasis, with Special Reference to Surra in the Philippine Islands. By W. E. Musgave, M. D., and Moses T. Clegg.

[1] *No. 6, 1903.*—New and Noteworthy Plants, I. The American Element in the Philippine Flora. By Elmer D. Merrill, Botanist. (Issued January 20, 1904.)

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[1] *No. 11, 1903, Biological Laboratory.*—Entomological Division, Bulletin No. 1: Preliminary Bulletin on Insects of the Cacao. (Prepared Especially for the Benefit of Farmers.) By Charles S. Banks, Entomologist.

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No. 24, 1904, Biological Laboratory.—Glanders: Its Diagnosis and Prevention (Together with a Report on Two Cases of Human Glanders Occurring in Manila and Some Notes on the Bacteriology and Polymorphism of Bacterium Mallei). By William B. Wherry, M. D.

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[1] Out of print.

[2] The first four bulletins in the ornithological series were published by the Ethnological Survey under the title "Bulletins of the Philippine Museum." Later ornithological publications of the Government appeared as publications of the Bureau of Government Laboratories.

(Concluded on third page of cover.)

PLATE I.

THE PHILIPPINE

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A. GENERAL SCIENCE

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THE BENGUET IGOROTS. A SOMATOLOGIC STUDY OF THE LIVE FOLK OF BENGUET AND LEPANTO-BONTOC.

By ROBERT BENNETT BEAN.

(From the Anatomical Laboratory, Philippine Medical School, Manila, P. I.)

INTRODUCTION.

During the intersessional vacation of the Medical School in the year 1908, I spent two months at Baguio, the capital of Benguet Province, in studying the physical characters of the natives. No casual observer would expect to find white people inside of brown skins, but I found European types among the Igorots. (Plate I.) Trips were made to Atok, Tublay, and Capangan with parties under the direction of William H. Pack, governor of Benguet Province, to whom credit and thanks are tendered for his kindly coöperation in the work and his assistance in establishing the good will of the natives. Dean C. Worcester, Secretary of the Interior, also has my sincere gratitude for enabling me to carry through the work and for his many personal favors during its progress. I made excursions to points near Baguio from time to time, and obtained a few additional measurements at the Benguet Sanitarium and among the camps of laborers located in the vicinity of the town.

Benguet Province is situated in the central part of northern Luzon: Baguio, the capital, being somewhat less than 300 kilometers due north of Manila and about 30 kilometers east of the seacoast. The mountains of Benguet form a part of the *Cordillera Central del Norte* of the island, the most inaccessible portions of which lie in the north of the province and in Lepanto-Bontoc. Baguio lies at an altitude of 1,500 meters above sea level. It has a temperate climate and is located among pine hills on an irregular plateau southwest of the center of the province at

the terminus of one of the most remarkable highways of the world. The latter is to a large extent carved out of solid rock and in many places the deep cañon of the Bued River is crossed by suspension bridges. The plateau on which Baguio is located rises northward along the west of the province in the form of a group of rugged mountains intersected by small streams that cut their way through narrow gorges to Lingayen Gulf and the China Sea, passing through Pangasinan as well as Union Provinces, the latter inhabited by Ilocanos, one of the most thrifty and energetic people of the Philippines, and great colonizers. The Ilocanos form the littoral population of the west coast of northern Luzon and have penetrated the mountains to some extent. The eastern part of the province from its extreme northern end to its southern limit is drained by the tributaries of the Agno River, beyond which are mountains separating it from the Province of Nueva Viscaya. The Province of Benguet is thus divided into mountain and valley, or highland and lowland. The entire province is practically inaccessible, except over the Benguet Road, over the Naguilan trail from San Fernando, Union, or the trail from Aringay, Province of Union. The rivers that pass out of the province are filled with water during part of the year; their beds are rough, the sides precipitous and the mountains steep and rugged, so that both mountains and rivers form very difficult ways of entry. The present governor is rapidly constructing trails in the mountains with a grade of from 3 to 5 per cent, the most audacious of these is nearing completion and will connect Benguet with the Province of Lepanto-Bontoc.

The inhabitants of this isolated region could have arrived only by crossing high and rugged mountains, or by picking their way along the beds of the rivers during the dry season. Whether they came of their own accord or were forced from the lowlands by other peoples may never be known. I believe the Igorots pushed into the mountains as bold pioneers in much the same way that the Puritan, the Scotch-Irish and the Cavalier crossed the Appalachians and settled the western part of the United States. They probably exterminated or absorbed any previous inhabitants and have built for themselves enduring monuments in their rock-ribbed and terraced rice paddies, and in the rock shelters for their dead. Their muscular development is phenomenal (19, 70,) and would put to shame the best American athletes. Their laws and customs are founded on justice and equity, and "an eye for an eye and a tooth for a tooth" is often carried out to the letter. Civilization has not yet greatly affected the Igorots and they are being protected from its evil influences as carefully as sedulous officials can protect them. They are one of the few uncivilized communities that civilization has touched yet not defiled.

The people of Atoc, in the western part of the province are a representative group of Igorots. Atoc is a bold point that juts out from

the terminus of one of the most remarkable highways of the world. The latter is to a large extent carved out of solid rock and in many places the deep cañon of the Bued River is crossed by suspension bridges. The plateau on which Baguio is located rises northward along the west of the province in the form of a group of rugged mountains intersected by small streams that cut their way through narrow gorges to Lingayen Gulf and the China Sea, passing through Pangasinan as well as Union Provinces, the latter inhabited by Ilocanos, one of the most thrifty and energetic people of the Philippines, and great colonizers. The Ilocanos form the littoral population of the west coast of northern Luzon and have penetrated the mountains to some extent. The eastern part of the province from its extreme northern end to its southern limit is drained by the tributaries of the Agno River, beyond which are mountains separating it from the Province of Nueva Viscaya. The Province of Benguet is thus divided into mountain and valley, or highland and lowland. The entire province is practically inaccessible, except over the Benguet Road, over the Naguilan trail from San Fernando, Union, or the trail from Aringay, Province of Union. The rivers that pass out of the province are filled with water during part of the year; their beds are rough, the sides precipitous and the mountains steep and rugged, so that both mountains and rivers form very difficult ways of entry. The present governor is rapidly constructing trails in the mountains with a grade of from 3 to 5 per cent, the most audacious of these is nearing completion and will connect Benguet with the Province of Lepanto-Bontoc.

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The people of Atoc, in the western part of the province are a representative group of Igorots. Atoc is a bold point that juts out from

the surrounding mountains at an altitude of 2,000 meters above sea level, and its precipitous sides furnish an almost impassible barrier against attack. The inhabitants of this region were the last of the Benguet Igorots to come under the jurisdiction of the United States of America, and it was only by superior force of arms that they finally submitted. They live on their rocky fortress, work the paddy fields of the valleys below, and return to their stronghold at night. They are a self-reliant and progressive people, with sound judgment and wise deliberation in their councils. The administration of their affairs is in their own hands under the guidance of the governor of the province. Their chief *baknon* (old man) has already roofed his house with galvanized iron for protection from the tremendous downpours of rain which are so frequent in this region, and others are following his example.

Men and women are on practically an equal footing. The men work away from home for means to provide food, shelter, and draft animals (for working the paddy fields), and when at home the men care for the children. The women work at home raising the small crops (*camotes*, coffee, etc.), prepare the food, and assist the men in the transportation of surplus products to distant markets over steep mountain trails, acting with the men as common carriers. The women also have a voice in the councils and often exercise a controlling influence. The life of the Igorots is an existence of ideal sexual equality in many respects, and civilized nations might profit by their example, for they impressed me as a remarkably contented and cheerful people.

However, the purpose of this article is not to present the moral qualities, but the physical characters of the Igorots. Observations and measurements were made of 101 adult males (16+ years), 10 adult females, and 30 boys between the ages of 5 and 15 years inclusive. I also measured a number of Japanese, Chinese, Ilocanos, and Tagalogs, but these data will be reserved to be presented in later papers on the various Filipino peoples. Four groups will be considered in detail with each observation or measurement. The nativity of the four groups is: Lepanto-Bontoc [15], mountains of western Benguet [73], the Agno River valley [30], and Baguio and vicinity [27]. Fourteen of the Lepanto-Bontoc Igorots are adult males, and 1 is a boy. Forty-six of the mountain Igorots are adult males, 10 are adult females, and the remainder are boys. Twenty-two from the valleys and 22 from Baguio and vicinity are adult males, the remainder boys. (Table I.)

METHODS EMPLOYED.

The body parts are measured from the ground up by means of a graduated vertical rod with a sliding horizontal pointer. Other measurements are made with sliding calipers (*compass d'appaisseur*-Colin). Lead electric fuse wire is used in taking head outlines, a hinged brass bar is employed to measure the facial index, and general descriptions

are given of hair, brows, eyes, ears, nose, and skin, with occasional sketches.

Measurements and observations are made on the naked body of each individual, except the women, the usual breech clout not interfering at all. Some difficulty is experienced in obtaining one measurement, that of the superior extremity of the great trochanter of the femur, due to the solidity and rigidity of the hip muscles as the individual stands in the erect posture.

My measurements of the Igorots follow the personal instructions which I received from Professor Manouvrier in Paris during the summer of 1906, and I wish at this time to express my gratitude for the painstaking care exercised by him through the course of my training. The methods employed have been used by me during the past two years, and as they will apply to future work on the natives of the Philippine Islands, a brief résumé of the most important is inserted here.

The individual should stand in the position of a soldier(67). Projections are then made with the anthropometer as follows, using the level of the soles of the feet as the base:

HEIGHTS.

1. *Body height.*—Allow the beam to fall with a click on the top of the head (*vertex*).

2. *Ear height.*—The beam should point into the external auditory meatus (*meatus acusticus externus*).

3. *Chin height.*—The point at lower edge of mandibular-symphysis (*protuberantia mentalis*).

4. *Sternum.*—Press down firmly in the suprasternal notch (*incisura jugularis*).

5. *Umbilicus.*—The level of its middle.

6. *Pubis.*—The superior border of pubic hair. (I use the actual level of the pubic spine [*tuberculum pubicum*]).

7. *Acromion.*—The level of its outer tip.

8. *The elbow* (*cubitus*).—The level of the joint furrow in the flesh, at the head of the radius (*capitulum radii*).

9. *Wrist* (*carpus*).—The level of the lower extremity of the styloid process (*processus styloidus*) of the radius.

10. *Tip of middle finger* (*digitus medius*) with hand extended.

11. *Trochanter.*—Press extremely hard on the upper end of the femur (*trochanter major*).

12. *Knee* (*genu*).—The line in the rear on the skin passing exactly through the joint at the upper outer end of the tibia (*condylus lateralis*).

BREADTHS.

(*Made with triple elbow calipers.*)

1. *Shoulder.*—Press hard on the outer tips of the acromion processes.

2. *Hip.*—The outer lips of the iliac crests (*crista iliaca*).

3. *Thigh.*—The outer part of the trochanter (*trochanter major*).

4. *Pelvis.*—From the anterior superior edge of the symphysis to the diamond-shaped depression in the back, over the lumbar region.

The masterful work of Rudolph Martin (*"Die Inlandstämme der Malayischen Halbinsel"* (25)) is freely utilized in the course of the present study because of the complete presentation in tabular form of the results of recent investigators regarding the people associated with eastern Asia.

The present article is divided into eight parts the last three of which form a summary; these parts are as follows:

I, Stature; II, Body Parts; III, Head Form; IV, Physiognomy; V, Descriptive Characters; VI, Somatologic Race Types; VII, Three Selected Types; VIII, Supplementary Theory of Heredity.

I. STATURE.

The Igorots are a people of small stature (below 160 centimeters) although many individuals are above the average and some are tall. (Table III.) The average or mean height of 104 adult males and 10 adult females is 151.0 and 146.7 centimeters, respectively.

Further analysis reveals the fact that these groups are not homogeneous. Only 60 per cent of the adult males are between the height of 150 and 162 centimeters, a wide range for so small a number of individuals. The mode or height of greatest frequency (hence the fashion) is 150 centimeters, although there is only one less individual at 152, 154, and 156 centimeters respectively. The median (which has an equal number of individuals above and below it) is 153 centimeters. The minimum is 141 centimeters, and the maximum is 170 centimeters. There is an even distribution of individuals between 148 and 158 centimeters; there are 25 above 158 and 11 below 148 centimeters. (Table II.) A curve constructed from the number of individuals at the various heights represented by ordinates and abscissæ would not be a normal Gaussian curve, but would be platykurtic (flat-topped(74))(45) with a tendency toward tallness, indicating great variability, and more than one type of man.

The mean height of 14 Bontoc Igorots is 158.6 centimeters. One is only 148 centimeters high, one about 156, and 7 are about 164 centimeters. The three groups are significant when considered in connection with similar ones from the highland and lowland regions.

The mean height of 46 adult male Igorots of the highland region is 154.9 centimeters, the minimum is 142, and the maximum is 170. The height is less than that of the Bontoc Igorots, and the variability is greater, but the height is more than that of the lowland Igorots.

The mean height of 22 adult males from the valley is 153.6 centimeters. The smallest is from Trinidad in the open country, and the two tallest are from Buguias, which is in the northern end of the province, near Lepanto-Bontoc. The mean height of the 5 men from Buguias is 155.2 centimeters, while that of the 5 from Trinidad is only 152 centimeters. This would suggest that there is an element of small people at Trinidad. The 5 men from Baguio and the 5 from Kabayan have a mean height of 156.8 and 151.2 centimeters respectively, which would indicate the same for Kabayan. However, five individuals are not enough from which to determine a mean height, although the measurements do indicate the characteristics of a part of the population.

The mean height of 22 adult males from Baguio and vicinity is 149.1 centi-

meters. Their nativity was not ascertained for lack of an interpreter, but many of these probably come from Trinidad. For this reason the group is not characteristic for the whole province, but for Trinidad, Baguio and vicinity.

The individuals of each of the three groups, Lepanto-Bontoc, Highland, and Lowland, may be divided into those of small, those of intermediate, and those of great height. The height of the small individuals varies around 148 centimeters (*cf.* Negrito); that of the large individuals around 165 centimeters (*cf.* European); and the height of the greatest number of individuals is about 154 centimeters (*cf.* Malay). The people of Atoc are slightly above and the people of Baguio and vicinity are slightly below the figures given, but the three groups are definitely represented there as elsewhere. The conclusion from the examination of the height alone is that at least three groups of people make up the Igorot population. (Table II.)

The mean height varies directly with the altitude, but probably this variation is not due to the effects of mountain or river, but to the difference in type of the individuals making up the population. The accessible parts have been influenced by infusions of blood from outside of the Province of Benguet, whereas the inhabitants of the inaccessible regions are more like the original type. However, it is possible that outsiders of a bold and daring nature penetrated to the most inaccessible regions, and these may have been tall individuals who increased the average height of the community by their presence and by their progeny.

The mean height of the Igorots is 3.6 centimeters greater than that given by Martin[26] for the inhabitants of the Malay Peninsula. It is also greater than that of the Veddahs of Ceylon (Sarasin), but it is less than that of the Annamites[24], the Japanese, the Koreans, the Javanese and various other peoples in the region adjoining eastern Asia.

Sexual differences in height can not be fairly stated because so few women were measured, but it may be of interest to note them.

The mean height of the female Igorots is 146.7 centimeters, the minimum 135 centimeters and the maximum 154 centimeters. The mode is 146 centimeters and the median 145 centimeters. The female height throughout the world is 7 per cent less than the male, or in other words the female is 93 per cent of the male height[27]. Therefore, since the mean height of the Igorot women should be only 144.1 centimeters they are proportionately taller than the men.

STATURE AND RACE.(50)

Although local conditions acting on the same people for many thousand years may effect a change in stature, yet it remains true that stature is a potent factor in race differentiation. Food and nutrition play a part in determining this characteristic, and artificial selection is at work in modern social life, tall individuals being selected in marriage because goodly stature in youth implies a bountiful store of vitality. Occupa-

tion and habitat may influence it in the individual, but this is not transmitted to the offspring. City life reduces stature, but attracts tall men, so that the one balances the other. The tall, hardy pioneer survives in the mountain, but poor nutriment causes a decrease in height; hence a similar balance is found there. However, these influences act only on the individual and if they become hereditary it must be after countless generations.

Racial differences in stature are characteristic and persistent. The Malays are everywhere inclined to be short, and the Polynesians are inclined to tallness. The Scotch are the tallest people of Europe, the southern Italians are almost dwarfs; the first live in the mountains and the latter inhabit the coast. The Adriatic has a body of very tall people along its northern borders, but the mountains of middle Europe are inhabited by short individuals. The Teutonic people have retained their height wherever they have gone. The inhabitants along the shores of Brittany, which were ravaged so fiercely by these northern barbarians, are taller than the people of the interior. The valleys south of Germany (Tyrol) have been infiltrated by the tall invader, leaving the short man in the mountains.

Many other instances could be cited to prove that stature is incident to race, but as the weight of evidence is in favor of this, the burden of proof rests with the opposition; as well argue that long heads are due to mountain height, because long-headed Igorots are found high up in the mountains, as to say that short stature is due to high altitude, or *vice versâ*. However, it may be that stature, like so many other characters, becomes altered by environment in the life of a single individual, but the altered condition is not transmitted, until, through countless generations in the same environment, the altered character becomes fixed and inheritable.

The stature of the Igorots then, is probably a racial character, and not a local condition.

STATURE AND AGE.

The stature of the boys as contrasted with that of the adult males, and the relation of growth to age deserve consideration. The ages which I have given are not exact in every instance, because age is determined by the number of rice harvests since the birth of the individual, but as the rice harvest is annual, this method of record is fairly accurate.

The individuals are arranged in small groups from the age of 5 to 20 years and in larger groups above this age. (Table IV.) The mean stature increases about 5 centimeters per year up to the age of 16, when the adult height is apparently reached, although a slightly greater height is found between 20 and 30. The height at 18 and 19 is less than that at 16 and 17, but the small number of individuals at 18 and 19 may account for this. For the same reason, the great height of 5 men above the age of 50 years, and that of the boys from 5 to 10 years of age, are not fair estimates.

The two most significant features of the relation of height to age are the apparently early maturity of the Igorots and their aquisition of maximum height at an earlier age than Europeans. This agrees with the conclusions of Martin(28), regarding the inhabitants of the Malay Peninsula. Hastings(17) has presented the average height for each age of 8,245 typical male American school children, his figures compared with the height of the Igorots shows a difference of about 10 centimeters in favor of the American children at each age up to 17, and a further increase of about 10 centimeters to the age of 19, when the American boy is 20 centimeters taller than the Igorot. The actual height as well as the growth of the American children conforms well with Topinard's deductions from measurements of 1,104,841 Europeans(61). The age in the latter instance is carried beyond 30 and the greatest height is found to be between 30 and 40 years. There is an annual increment in height up to 35 years(60). This increment decreases during the period of from 1 to 5 years, makes a sudden slight increase at 6, remains stationary from 7 to 10, increases progressively from 11 to 16, decreases suddenly at 17 and slowly thereafter to the age of 35, when the increase in height ceases.

The growth of the Igorots is similar to this.

The stature increases steadily from 10 to 17 years, there is a decrease to the age of 20, then an increase to the maximum between 20 and 30. After 30 the height decreases slightly to the age of 50.

The relative height increment of the Igorot boy is not unlike that of the European girl,[1] because the annual increment decreases in both from the age of 13 to 19(60).

DISCUSSION OF STATURE.

In conclusion it may be said that the growth of the Igorot is similar to that of the European, but that it is more rapid. The Igorot male is as well developed at the age of 16 years, as the European at 18. The maximum height of the Igorot is reached between 20 and 30, that of the European ten years later. The relative growth of the Igorot boy is intermediate between that of the European girl and the European boy. The height of the different groups of Igorots(73) varies directly with the altitude and inaccessibility of their location, but the rate of growth, the time of maturity and the actual height are probably characteristic of the stock and not due to environment.

The stature of the adult male Igorots is represented by a curve which is seen to be irregular. (Fig. 1.) With only 104 individuals some irregularities in the curve might be expected, which would be smoothed if 1,000 had been measured, but evidence indicates that irregularities in a curve of 100 individuals mean a diversity in type due to previous mix-

[1] European is used in the sense of the white or Caucasian.

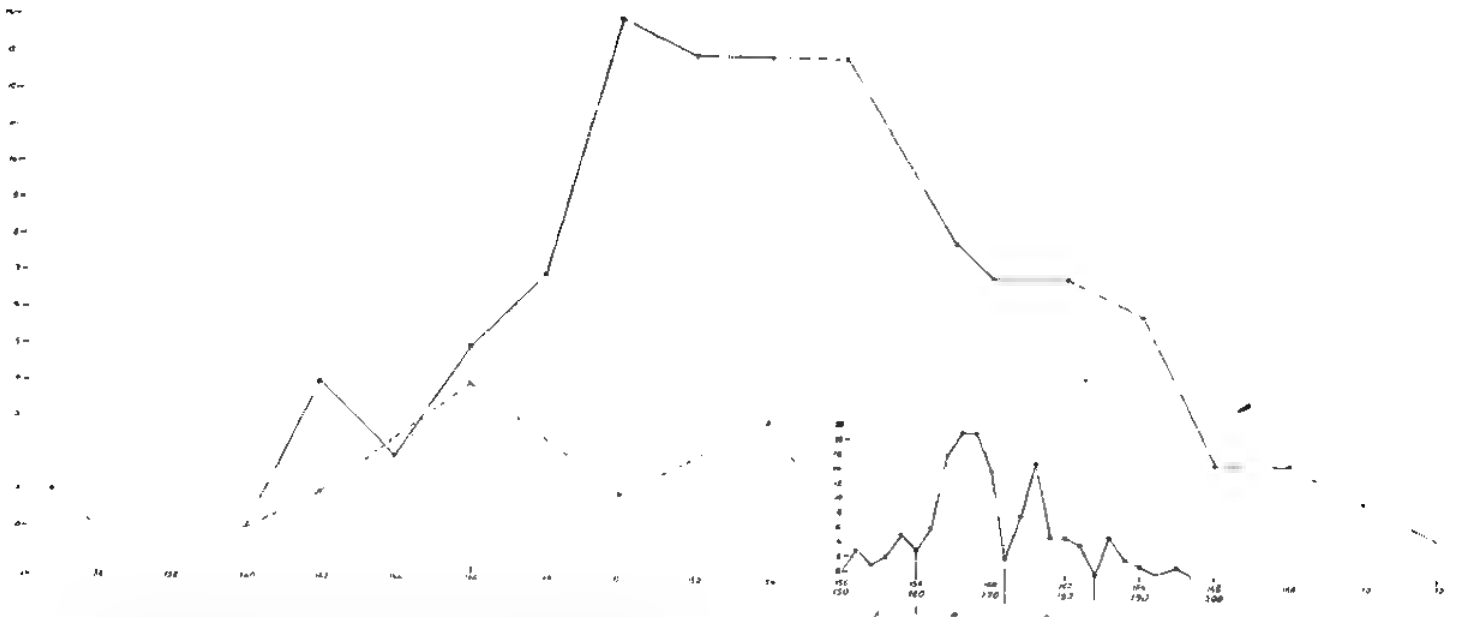


FIG. 1.—The large vertical column of numbers 0–11, represents the absolute number of Igorots, and the large horizontal row of numbers, 134–172, the stature of the Igorots.

The vertical column of small heavy numbers 0–20, represents the absolute number of male negroes and the lower row of heavy horizontal numbers, 150–200, the stature of the male negroes.

Large scale and figure = { —— male Igorots. / _ _ female Igorots.

Small scale and figure —— male negroes

A = Hottentot, Bushman, Negrito.
B = Guinea Coast negro
C = Mulatto.
D = Kaffir negro.

ing of types. This meaning is obscured by constructing a curve with 1,000 individuals from the same population.

Take for instance the height of about 150 negroes that I measured at the Johns Hopkins Hospital Dispensary in 1906. There is great irregularity in the curve, which has seven summits, as may be seen in the small figure in the chart. Each of the summits represents a group of negroes well recognized in the United States, and known to exist in about the proportion and with the height given. Pygmies are rare, Hottentots are not plentiful, and extremely tall negroes are seldom found. The Guinea Coast negro, the Kaffir and the mulatto make up the bulk of the negro population in America. With 1,000 or more individuals, the types as represented by the height would be obscured and only an average negro height would be the result. Topinard(62) classifies 48,282 negroes and mulattoes by height and arrives at a single result, to wit: The average of the American is the same as that of the African negroes, namely, 168.1 centimeters. This is a not insignificant result in itself, but it leaves much to be desired in the classification of negro types. Much depends upon the selection of individuals, but in a random sample with no selection there should be no spurious types. There was no conscious selection of negroes or of Igorots, but every available individual was measured.

Three summits are evident in the curve of height for the female Igorots as well as for the males. The summit for tall women (160 centimeters) is considerably prolonged, while that for small ones is not. The interpretation of the curve would be as follows:

The large central portion represents the majority of the people, and this is the most frequent type. The two extremes of the curve represent a small and a tall people who have mixed with the others. The small people are few in number and have had slight influence in altering the type, while the tall ones are in greater numbers and have modified it considerably, causing the central part of the curve to be flat-topped by increasing the number of individuals with height above the mean. Reasoning from this premise we may conclude that the original stocks of Igorots had a mean height of about 150 centimeters or less, which is the same as that of the people of the inland part of the Malay Peninsula(26). Martin's curve, however, shows three summits for both males and females, and there is evidence of three peoples among his subjects, so one must search back of this for the primitive stock. Whatever that may have been, the influence of a tall people is evident, and this came at a remote time, when the tall people were present in great numbers. Later came the influence of the small people, which there is good reason to believe were the Negritos. The mean height of 10 male Negritos of the Philippines according to A. B. Meyers is 144.5 centimeters, with extremes of 140.1 and 150.5 centimeters respectively(29); Montano gives the mean height of 18 male Philippine Negritos as 148.5 centimeters; Deniker(14) presents 42 Aeta-Negritos with a mean height of 146.5; Keane(21) gives the mean height 147.3; and Reed(47) states that of 48 mixed Negritos to be 146.3 centimeters. The height of 4 adult male Igorots is 142 centimeters, and there are 32 below 150.5 centimeters. The height of 5 male adults is nearly 170, and 60 per cent are above 150 centimeters. It is easy to conceive that a few Negritos would become attached to the Igorots in their progressive conquest of the mountains, but it is not so easy to believe that a tall people has joined them in the Philippines to make up about one-third of their number. Stray refugees or adventurers may have come to them from time to time

in their mountain fastnesses, as in the case of an Ilocano, 168 centimeters in height, who came to Atoc from Union Province at the age of 15 years, fought in the war parties of the chiefs and was accepted as one of them for his continual daring and bravery. He is taller than the average Igorot, but not above the height of three of those measured. The Spanish influence must be reckoned with because the Spaniards have been in contact with the Igorots for at least fifty years (?), although no individual measured showed any indication of the Spanish influence in physical characters. A few tall men added to the Igorots from time to time may have had a slight influence, but they could not have altered the average height materially; furthermore the inaccessible parts have the tallest individuals, and the Bontoc Igorots, the most inaccessible and remote, are the tallest of the Igorots.

II. PROPORTION OF THE BODY PARTS.

The measurements made on the living are necessarily more inaccurate than those upon the skeleton, but with proper precautions and great care they may be used as differential factors in the physical anthropology of a people.

UPPER EXTREMITY.

(Extremitas superior.)

The Igorots are essentially short-armed, although there are long armed individuals and the several groups show differences in the absolute length as well as the relative length. The mean (absolute) length of the upper extremity of 104 adult males is 67.82 centimeters, which is less than that of any other related Malay peoples, except the Senoi group(30) in the Malay Peninsula, and it is little less than that of the Japanese. The length decreases progressively with locality and altitude from the highlands to the lowlands as may be illustrated by grouping to show the mode and the extremes:

Absolute length of upper extremity, in centimeters.

Group, sex and age.	49 and less.	50–54.	55–59.	60–64.	65–69.	70–74.	75.	Total.
Bontoc					3	9	2	14
Highlands				5	26	15		46
Lowlands		1		12	22	7		41
Adult males		1	2	17	51	31	2	104
Women			2	5	3			10
Boys, 12 to 15		1	7	10	1			19
Boys, 10 to 12	1	4	2					7
Boys, 10 and less	3	2						5

The range of variation, judged by the difference between the extremes, and the spread of the mode, is greater in the lowland than in the highland or Bontoc groups, which indicates greater diversity of type in the lowlands. Reasoning from this premise, the conclusion is that Igorots from the lowlands are more recently mixed than the people from the highlands or from Bontoc.

The variation of the upper extremity as expressed by the difference between

minimum and maximum, is 31 per cent of the maximum length for the entire extremity, 21 per cent for the upper arm, 30 per cent for the forearm, and 40 per cent for the hand. The actual variation in centimeters is:

	Centimeters.
Entire extremity	23.1
Upper arm	7.4
Forearm	9.1
Hand	8.0

The upper arm which is least variable is therefore a better factor for testing type differences, and the greatest difference is found between the Lowland and Highland Igorots in this part. Its mean length for the Bontoc Igorots is 0.8 centimeter greater than that of the highland group, and 2.0 centimeters greater than that of the Igorots of the lowlands. The mode is 1 centimeter greater for the Bontoc Igorots than for the highland people and 4 centimeters greater than for those of the lowlands. (Tables V, VI, and VII.)

According to this standard and by the total length of the upper extremity, the Lowland Igorots correspond to the Senoi of Martin(31), the Highland and Bontoc Igorots to the remainder of the population of the Malay Peninsula, as this table indicates:

Mean lengths of upper extremity, in centimeters.

Group.	Entire extremity.		Arm minus hand.		Upper arm.		Forearm.		Hand.	
	Absolute.	Relative	Absolute.	Relative	Absolute.	Relative.	Absolute	Relative.	Absolute.	Relative.
Senoi	66.7	43.1	50.5	32.3	28.0	18.1	21.4	13.8	16.8	10.9
Blandas	69.9	45.4	52.5	34.0	30.3	19.5	22.2	14.3	17.4	11.3
Malayen	71.8	45.9	53.1	34.0	30.4	19.1	22.2	13.8	18.2	11.4
Lowland	66.5	43.8	50.5	33.3	28.6	18.7	22.0	14.5	16.2	10.6
Highland	68.3	43.9	52.1	35.6	29.8	19.8	22.4	14.4	16.0	10.3
Bontoc	71.6	45.2	53.9	33.9	30.6	19.2	23.3	14.8	17.8	11.2
Igorot women	62.8	42.7	47.6	32.4	27.1	18.5	20.5	14.0	15.1	10.3

Martin's Senoi group is almost exactly the same as the Lowland Igorots in the absolute and relative length of the entire upper extremity, the upper arm and the hand, and in the absolute length of the arm minus hand, and the forearm. The Igorots from the lowlands have a relatively longer forearm, and a relatively longer arm minus hand than the Senoi.

Martin's groups of Blandas and Malayen are similar to the Highland and the Bontoc Igorots in every measurement, except that of the forearm (absolute and relative), wherein the Bontoc Igorots exceed all others. The relative forearm length of the Bontoc is 14.8 centimeters which is equal to that of certain Europeans, below that of other Europeans, and considerably less than that of the negro(34). It corresponds to the Menangkabau-Malayen and the southern Chinese of Hagen(33), and ex-

cupies a position midway between that of the Japanese and the South American Indian.

The relative upper arm length of the Highland Igorots, which is the same as that of the European (19.8 centimeters) is as great as that of any other people so far measured except the Sikh (20.1 centimeters) (33). The relative hand length of the Bontoc is also the same as that of the European, and the relative length of the entire upper extremity is but a trifle less. That of the parts of the upper extremity and of the entire upper extremity place the Bontoc Igorots nearer the European than are the Highland or Lowland Igorots, and the Highland are nearer than the Lowland. The hand of the Highland, and of the Lowland as well, is unlike the European, Chinese, or negro, because it is relatively shorter. It is the same as that of the Igorot women, but less than that of any other people except the Senoi of Martin.

The absolute and relative length of the entire upper extremity, and of each of its parts is slightly less for the women than for any group of men. The hands of the women and the men of the highland group, however, are exactly the same in relative length.

The ratio of the forearm to the upper arm, the so-called "brachial index," is important to establish the relationship of the Igorots to other people. This index is 76.2 for the adult male and 75.6 for the adult female Igorots. It is 76.9 for the Lowland, 75.2 for the Highland, and 75.1 for the Bontoc. The brachial index is an additional differentiating factor for the Lowland Igorots, placing them in the same class as the Senoi, while the highland and Bontoc groups in this factor, as in so many others, are more like the European. The brachial index of the living has been determined by many different methods, and by so many different authors, that divergent results are reached on the same people. For instance Sarasin found the index of the Veddahs to be 91.0, while Martin determined it to be 75.8(32); Weisbach gives for Germans an index of 83.5 and Teumin for the Russian Jews one of 72. As Martin remarks there is great need for a fundamental reform in the methods of measuring the living.

The brachial index on the skeleton is greater than on the living, and is given by Martin for Europeans as 72.5, for Negritos, 83, and for the Senoi, 78.9. On the living, Martin gives the Senoi, 76.0 and the Blandas, 73.2, which again places the Senoi and the Lowland in the same class, while the Bontocs are nearer the Blandas.

LOWER EXTREMITY.

(Extremitas inferior.)

The measurements of the parts of the lower extremity are more exact than those of the upper, because in the latter there may be unconscious and unnoticed shifting of the parts when the measurements are being made, whereas in the former there is greater stability because the parts are placed firmly on the ground. The height of the pubis taken from the pubic spine is more accurate than the height of the trochanter, because of the accessibility and the ease with which the spine is located, whereas the heavy fascia, muscles and ligaments over the trochanter interfere with exact work.

Parallel measurements for comparison indicate that the pubis is

slightly lower than the trochanter in the Igorots, but this may be due to the heavy gluteal muscles and fascia lata occurring in these incessant mountain climbers.

Height of trochanter and pubic spine compared, in centimeters.

Group.	Number.	Trochanter.	Pubic spine.
Bontoc	14	82.0	81.9
Highland	46	79.9	77.9
Lowland	44	78.1	76.0
Total	104	79.4	77.6
Women	10	74.1	71.7

Here again as in the other measurements, the Bontoc is the greatest, the Lowland least in absolute length, and the highland group is between the two. These measurements represent the absolute length of the entire lower extremity, and a glance at the next table will show that the relative length follows slightly the absolute length. Again there is the similarity between the three groups of the Malay Peninsula(35) and the Igorots.

Length of lower extremity, in centimeters.

Group.	Number.	Entire.		Approximate height of ankle.	
		Absolute.	Relative.	Absolute.	Relative.
Bontoc	14	82.0	51.7	3.6	3 70
Highland	46	78.9	51.6	5 2	3 55
Lowland	44	78.1	51.5	5 1	3 50
Total	104	79.4	51.6	5 4	3 55
Women	10	74.1	50.5	---	-

The lowland group again corresponds to the Senoi, the relative length of the Bontoc lower extremity is almost identical with that of the European, and is less than that of the negro, but considerably more than the Japanese.

The women have absolutely and relatively shorter legs than the men of the highlands, with whom they should always be compared, because they belong to that group.

The length of the leg-minus-foot is approximate because the ankle height was obtained on but thirteen Igorots. However, the average of even so small a number emphasizes a fact that I observed constantly, to wit: The distance from the internal condyle to the sole of the foot is so short that it could with difficulty be measured, especially where the surface of the ground on which the individuals stood was rugged. The ankle height is similar to the hand length, especially in so far as the shortness is more pronounced in the highland and lowland group than in the Bontoc.

Length of leg-minus-foot, in centimeters.

Group.	Number.	Absolute.	Relative
Bontoc	14	76.4	48.0
Highland	46	74.7	48.1
Lowland	44	73.0	48.0
Total	104	74	48.1

The absolute length of the leg-minus-foot follows the stature closely, but the relative does not, since it is equal in all the groups.

The intermembral index may be calculated from this, comparing it with the arm-minus-hand, but a fairer consideration under the circumstances would be a comparison of the entire lower with the entire upper extremity. Both are given so that the intermembral-index may be compared with that for the inhabitants of the Malay Peninsula (36).

Intermembral index.

Group	Number.	Arm-minus-hand vs. leg-minus-foot.		Entire extremity, upper vs. lower.	
		Bean.	Martin.	Bean.	Martin.
Bontoc	14	70.6	Blandas 71.4	B. 87.5	Blandas 87.3
Highland	46	70.0	Besisi 70.1	H. 85.4	Malayen 85.1
Lowland	44	69.2	Senoi I. 69.7	L. 85.1	Senoi I. 84.1
Total	104	70.0		85.1	
Women	10			84.7	

The Igorots have relatively longer arms as a whole in proportion to their legs than the Malays of the peninsula, but there is a general concordance as usual, and a similarity exists especially between the lowlands and the Senoi. The arm of the women although 5 centimeters absolutely shorter than that of the men, is relatively to the leg, about as long.

For the parts of the lower extremity the absolute length of the upper leg (femur) is the difference between the height of the knee and the trochanter, and the absolute length of the lower leg (crus) is the difference between the height of the knee and ankle.

Length of the parts of the lower extremity, in centimeters.

Group.	Number.	Upper leg.		Lower leg.		Tibio-femoral index.	Stature.
		Absolute.	Relative.	Absolute.	Relative.		
Bontoc	14	39.4	24.9	36.9	23.3	93.6	158.6
Highland	46	38.3	24.5	36.3	23.4	94.7	154.9
Lowland	44	37.2	24.5	35.8	23.6	96.2	154.6
Total	104	38.0	24.7	36.0	23.4	94.7	154.0
Women	10	33.9	23.1				146.7

All the lengths show in general the same relation between the groups of the Malay Peninsula and those of the Igorots as the preceding measurements, except that the tibio-femoral index is from five to ten points higher for the Igorots. This corresponds to the crural index of Hagen(36) for the Malay and Melanesian people, which is 90.8 *"bei Alas,"* and 97.4 *"bei Neu Mecklenburgern."* The measurements are equal to those of the European and Japanese, and are less than all other related East Asiatic people except the Aino. The length of the upper leg, both absolute and relative, is less for the Igorot women than for any of the women from the Malay peninsula.

The relative length of the upper leg follows the absolute, as does the relative length of the entire lower extremity, so one may say the length of the lower extremity is determined by the length of the upper leg, which in its turn determines the stature of the individual. In other words the correlation of stature and length of upper leg is pronounced.

The same is not true of the lower leg, but rather the opposite. With absolute increase of length of the lower leg, the relative length decreases, so that the shortest Igorots have relatively the longest lower legs.

The tibio-femoral index presents this clearly. Compare it with the brachial index, and a striking similarity between forearm and lower leg is noticed. The shortest individuals have relatively the longest forearms and lower legs, while the longest individuals present the reverse.

It may be of interest in connection with the body parts to present the absolute dimensions of an Igorot and of a Senoi man(38). Selecting an individual Igorot with the same height as the Senoi man, the body parts correspond almost exactly, except that the hand of the Igorot is shorter and the upper arm longer than the same members of the Senoi. This is corroborative evidence in a special case of the general evidence obtained from the averages of the body parts. (Fig. 2.)

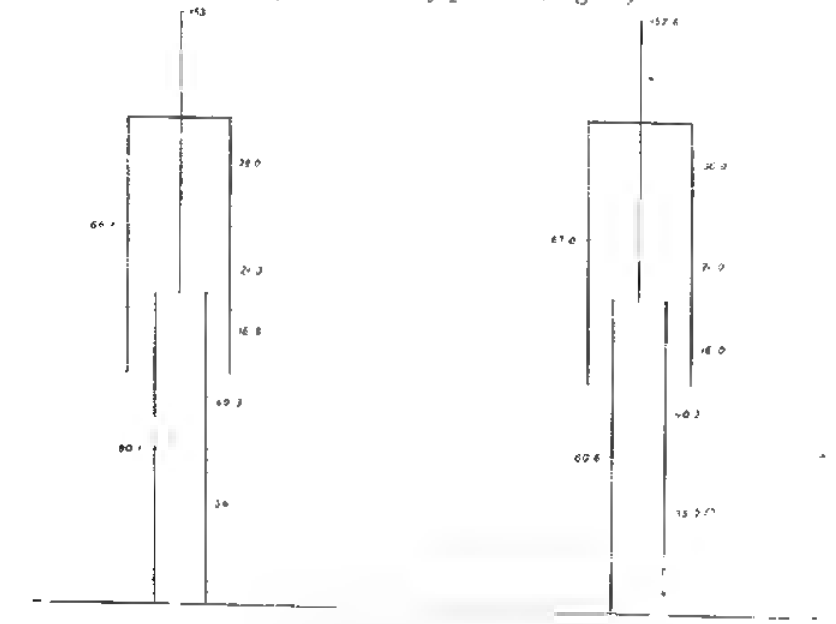


FIG. 2.—Absolute length (in centimeters) of the body parts of a Senoi man (left figure) and an Igorot man (right figure)

The absolute and relative length of the extremities of the Igorots may be stated in contrast with similar measurements of other people.

The absolute length of the upper extremity of the Igorots is less than that of any other Eastern Asiatic people except the Senoi. The Northern Chinese have the greatest and the Japanese an intermediate length, or nearer the length of the Igorot arm.

The relative length of the upper extremity of the Igorots is less than that of the majority of the associated people. However, the Japanese and the Senoi have this relation shorter; the former the shortest of all, and the Veddahs and Ainos the longest, with the Europeans intermediate. The Igorots are midway between the Europeans and the Japanese.

The absolute length of the lower extremity of the Igorots is less than that of any other except the Japanese and Coelin Chinese, who have this dimension slightly less than the Igorots. The Japanese have the shortest and the negroes the longest legs of all people, while the Europeans are intermediate. The Aino and the Igorot are almost identical in leg length, and are midway between the Japanese and the European.

Martin's observations lead him to conclude that relative leg length and absolute leg length follow each other closely, in which I agree with him. The relative leg length of the Igorot is slightly nearer the European standard, but otherwise corresponds to the absolute leg length.

SHOULDER-HIP-PELVIS.

The shoulder width (acromian), and the width of the hips (iliac) may be contrasted and compared with the height, to determine relationships and differences.

Relation of the (iliac) width of the hips to the (acromian) width of the shoulders.

Group.	Number.	Shoulder.		Hip (coxa).		Relative $\frac{\text{hip}}{\text{shoulder breadth}}$.	Pelvis	
		Absolute.	Relative.	Absolute.	Relative.		Ant.-post.	Pelvic index.
Bontoc	14	34.9	22.0	26.4	16.6	75.6		
Highland	16	35.6	22.6	26.4	17.0	75.4		
Lowland	64	34.4	22.7	25.1	16.6	72.9	17.2	68.7
Total	104			25.6				
Women	10	32.0	21.3	26.0	17.7	81.2		
French men	40		18.9		16.9	89.3		
French women	30		16.3		18.4	91.8		
Belgian men	30					82.5	(a)	
Belgian women	30		22.0			91.5		
Negro men	2020		21.3		16.5			
European men	83				17.2			

a Topinard.[66]

The shoulders of the men are relatively (to the stature of course) wider than those of the women and the Lowland men have the widest shoulders. The hips of the women are relatively wider than those of the men. The $\frac{\text{hip}}{\text{shoulder}}$ breadth is naturally greater among the women, but this is much less for Igorots than for Europeans.

The Bontoc and Highland Igorots approach the European more closely than do the Lowland. The difference between the Bontoc and the Frenchmen is 5.2, the difference between the Lowland and the Frenchmen is 7.9, and the difference between the Igorot women and the French women is 10.6. The reason for this disparity on the part of the Igorot women is not so much in poorly developed hips as in well-developed shoulders due to field work and burden bearing.

The Igorots are intermediate between the European and the negro in relative hip breadth.

The pelvic index is given for the lowland group alone, because it was determined for no other.

THE UMBILICUS

The position of the umbilicus in relation to the pubis and the supra-sternal notch, although it is more variable than such fixed points as the two last mentioned, is of importance in type differentiation. Its importance embryologically can not be denied, but whether its position is due to developmental phenomena or not, remains to be determined. I present for the first time the index of the umbilicus, and emphasize its singificance.

The index is found by dividing the distance of the umbilicus from the pubic spine by its distance from the supra-sternal notch. This indicates its relative position on the body. If the index is high, the umbilicus is relatively near the suprasternal notch, but if low, it is relatively near the pubic spine.

I propose the name of omphalic index for the index of the umbilicus. Divisions into hyper-, meso-, and hypo-omphalic would follow naturally for the high, intermediate, and the low umbilicus. It is inexpedient at this time to attempt a definition of the limits of these three classes of omphalites, although I am inclined to believe that the Igorots are hypo-omphalic.

OMPHALIC INDEX.

Group.	Pubis.	Umbilicus.	Sternum.	Sternum to umbilicus.	Pubis to umbilicus.	Index of umbilicus.
Bontoc	81.9	95.6	129.6	34.0	13.7	40.3
Highland	77.9	91.9	126.5	34.6	14.0	40.4
Lowland	76.0	89.8	122.7	32.9	13.8	41.9
Total	77.6	91.5	125.3	33.8	13.9	41.1
Highland women	71.7	87.6	119.4	31.8	15.9	50.0

The sexual differentiation by the omphalic index is great. The women have an index that is 25 per cent higher than the men. The differences

between the three groups of men is not so marked, but the lowland group resembles the women more than any other. The tall men have a low and the short men have a high index.

Childbearing in women may have some influence on the position of the umbilicus. So may the protrusion of the abdomen from any cause, such as obesity, ascites, rice feeding, etc.

The relation of omphalic index to age is as follows:

Omphalic index and age.

Group-age.	Number.	Pubis.	Umbilicus.	Sternum.	Sternum to umbilicus.	Pubis to umbilicus.	Omphalic index.
Below 10	5	54.3	64.3	86.7	22.4	10.0	44.6
10–11	7	61.1	71.3	98.2	26.9	10.2	38.0
12–13	6	68.2	79.5	107.6	28.1	11.3	40.2
14–15	13	70.5	83.0	111.0	31.0	12.5	40.3
16–17	9	76.8	90.8	124.2	33.4	14.0	41.9

The index is high before the age of ten and decreases thereafter. The decided drop at 10–11 may be erroneous. At the age of 16 the position has reached that of the adult. The position of the umbilicus in the small male child is similar to that of the woman.

BODY LENGTH AND NECK LENGTH.

The stature may be divided into four parts: Head length (chin to vertex), neck length (chin to sternum), body length (sternum to pubic spine), and leg length (trochanter to sole). The leg length has been given, the other three remain. The body length is said to be 4 centimeters less than the distance from the suprasternal notch to the pubis[37], and the upper end of the leg is parallel with the lower end of the body, or 4 centimeters above the pubis. However, I find only 2 centimeters' difference between the pubis and the trochanter and as the pubic spine is more definite than the trochanter I prefer to use the spine.

The body length from the supra-sternal notch to the pubic spine is as follows:

Body length (truncus).

Group.	Absolute.	Relative.
Bontoc	47.7	30.0
Highland	48.6	31.3
Lowland	46.7	30.8
Total	47.7	31.0
Women	47.7	32.3

Compared with Martin's figures for the Malay Peninsula, the body length is slightly greater for the Igorots, and especially is this true of the highland group. The lowland is exactly the same as Senoi II, in absolute length, but relative to stature, the Lowland Igorot has a longer body. The body of the women is exactly as long as that of the men, and relative to stature it is longer.

The neck length presents unusual differences. The neck of the Highland Igorots is the shortest, even shorter than the women's, both absolutely and relatively; that of the Lowland Igorot is longer than any others, even the Bontoc being shorter.

Neck length (collum).

Group.	Absolute.	Relative
Bontoc	7.2	4.5
Highland	6.4	4.2
Lowland	7.8	4.1
Total	7.1	4.6
Women	6.6	4.5

The women have relatively as long necks as any of the men; although they are not exactly swan-like, there is symmetry and beauty in their lines and proportions.

III. HEAD FORM.

The length of the head is measured from the glabella to the maximum occipital point (*lorus occipitalis*), the greatest breadth is taken, and also the height from the external auditory meatus to the bregma. The following outlines are made with electric fuse wire:

1. *Sagittal:* From the glabella to the external occipital protuberance;
2. *Horizontal:* Above the superciliary ridges and around the maximum occipital point;
3. *Coronal:* From the root of the zygomatic process on each side across the vertex.

Electric fuse wire was chosen after trying many materials, because of its lightness, rigidity and pliability. If care is exercised, the shape of the head is retained perfectly, the hair interfering in only a few instances. This method of obtaining outlines of the head on the living, while open to objection, nevertheless furnishes a ready and convenient means of securing at least the approximate head form. The sagittal outline is especially valuable, because of its greater accuracy.

The measurements of the head are reduced to skull measurements by deducting 10 millimeters from each diameter, and the skull size as thus determined is used

in the calculation of the cephalic index. The $\frac{\text{breadth}}{\text{length}}$ index is then classified as follows:

Hyper-dolichocephalic	70 and less.
Dolichocephalic	70 to 74.9
Mesocephalic	75 to 79.9
Brachycephalic	80 to 84.9
Hyper-brachycephalic	85 and more.

Aurel von Torok's(68) classification is useful in determining the actual size of the skull and its length in connection with the $\frac{\text{breadth}}{\text{length}}$ index. He uses symbols which are the initial letters of the three groups representing the three sizes of length and the three of width of the skull, namely, small, medium, and large. These will be symbolized by their English equivalents, *s*, *m*, and *l* as follows:

	s=narrow (short).	m=medium.	l=wide (long).
	mm.	*mm*	*mm*
Greatest skull width varies 101 to 173 mm	101–125	126–149	150–173
Greatest skull lenght varies 143 to 224 mm	143–169	170–196	197–224

Each skull is given a number, 1 to 82, which corresponds to its length in millimeters; No. 1=143 millimeters and No. 82=224 millimeters.

Cephalic index—male adult Igorots.

Type.	m/s							m/m												l/l	Total.
Number	12	11	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	
Dolichocephalic							1				1	5	7	3	8	5	5	2	3						41
Mesocephalic								1	3	2	6	6	9	3	6	3	2	1	1						43
Brachycephalic	1		1	1	2	2		1	3	1	1				2										18
1 hyperbrachycephalic at 80, 1 hyperdolichocephalic at do																									2
Total																									101

Let the symbol above the line represent the head width and the symbol below represent the head length, then the classes fall almost entirely in the m/m group or medium sized heads.

Class	Number.	s/s	m/s	s/m	m/m	l/m	m/l	l/l
Hyperdolichocephalic	1	0	0	0	1	0	0	0
Dolichocephalic	41	0	0	0	40	0	0	0
Mesocephalic	43	0	1	0	42	0	0	0
Brachycephalic	18	0	7	0	11	0	0	0
Hyperbrachycephalic	1	0	0	0	1	0	0	0
Total	104	0	8	0	95	0	0	0

There are no heads larger than medium size, but there are 9 smaller ones, 7 of which are brachycephalic. The smallest head of the series is dolichocephalic. There is a preponderance of dolichocephalic heads [41] over brachycephalic [18] which indicates that the Igorots are largely a dolichocephalic people, with medium sized heads and that the brachycephalic portion of the population has small heads.

A more detailed analysis reveals the relationship of the head form in different localities. It is to be seen that the Bontoc group is fundamentally dolichocephalic, the highland is largely dolichocephalic and mesocephalic, while the lowland is for the greater part mesocephalic and brachycephalic. The percentage of dolichocephalic heads decreases from 57 in the Bontoc group to 29 in the lowland; that of mesocephalic heads increases from 29 in the Bontoc to 46 in the lowland; while the percentage of brachycephalic heads increases from 14 in the Bontoc to 25 in the lowland group. It is of interest to note that 54 per cent of the brachycephalic heads in the lowland group belong to the m/s class, 46 belong to the m/m, and 86 per cent of the m/s brachycephals are in the lowland group, whereas only 14 per cent are found in the highland and none in the Bontoc. The Bontoc group has not only a larger percentage of dolichocephalic heads and a smaller of mesocephalic and brachycephalic than the other groups, but there are no small heads in the Bontoc group.

Cephalic index by locality.

Group.	Class.	Number	s/s	m/s	m/m	Per cent.
Bontoc	Dolichocephalic	8	0	0	8	57
	Mesocephalic	4	0	0	4	29
	Brachycephalic	2	0	0	2	14
	Total	14	0	0	14	100
Highland	Hyperdolichocephalic	1	0	0	1	2
	Dolichocephalic	20	1	0	19	44
	Mesocephalic	19	0	0	19	41
	Brachycephalic	5	0	1	4	11
	Hyperbrachycephalic	1	0	0	1	2
	Total	46	1	1	44	100
Lowland	Dolichocephalic	13	0	0	13	29
	Mesocephalic	20	0	1	19	46
	Brachycephalic	11	0	6	5	25
	Total	44	0	7	37	100

It has already been demonstrated from von Török's classification of the cephalic index that neither the length nor the breadth of the Igorot head is above medium size, and at least one group, the Lowland, has head dimensions below medium size.

Head dimensions of the living.

Group	Number.	Head.		Breadth, length index.[a]	Auricular bregmatic height.	Height length index.
		Length.	Breadth.			
Bontoc	14	18.8	14.5	77.1	13.1	70.0
Highland	46	18.9	14.7	77.8	13.3	70.4
Lowland	41	18.6	14.6	78.5	12.7	68.3
Total	101	18.8	14.6	77.6	12.9	68.6
Women	10	18.2	14.1	77.5	12.3	67.6
Bontoc (Jenks, 19)	32	19.2	15.2	79.1		

[a] The index should be reduced from 0.5 to 2 points to equal the skull index.

The Igorots are more dolichocephalic than the eastern Asiatic people, but less so than the tribes of India. The Bontoc and Highland $\frac{\text{breadth}}{\text{length}}$ index is dolichocephalic and slightly mesocephalic and the Lowland is mesocephalic. The women have the same $\frac{\text{breadth}}{\text{length}}$ index as the men and the $\frac{\text{height}}{\text{length}}$ index is similar to the $\frac{\text{breadth}}{\text{length}}$ in its relationships, but the women are less high headed than the men. The Bontoc and highland groups are higher headed than any other people of the Malay Peninsula or of eastern Asia, except the southern Perak Malays(1) who are four points higher.

As the Lowland Igorots, who are largely brachycephalic, have low heads and the Bontoc Igorots who are dolichocephalic have high heads, it is to be presumed that dolichocephalic, or long heads, are high, and brachycephalic, or short heads, are low. However, the reverse is known to be true, although when I first noticed the group variations, I thought the Igorots might be different in this respect from other people, but comparing the $\frac{\text{breadth}}{\text{length}}$ index of the head with the $\frac{\text{height}}{\text{length}}$ the result is as follows:

Comparison of $\frac{\text{breadth}}{\text{length}}$ with $\frac{\text{height}}{\text{length}}$ index of the head.

Index hl	63	64	65	66	67	68	69	70	71	72	73	74	75
Dolichocephalic	1	3	8	7	4	4	5	2		1		1	
Mesocephalic	1	1	1	4	1	6	16	7	3	3	3		1
Brachycephalic				1	1	1	2	2	2	5	2		

The dolichocephalic heads are low, the brachycephalic are high and the mesocephalic are intermediate. How, then, can the low $\frac{\text{height}}{\text{length}}$ index of the lowland group be accounted for when it is known that this group is largely brachycephalic? A closer examination of the cephalic index reveals the fact that the dolichocephalic heads of the lowland group have a very low $\frac{\text{height}}{\text{length}}$ index which influences the average of the group so as to lower it. It is seen from the above table of comparative indices that the $\frac{\text{height}}{\text{length}}$ index of the dolichocephalic heads is grouped about 65 and 69. There are high long heads and low long heads, the latter are found largely in the lowlands, and the former are found largely in the highlands.

The widest head breadth compared with the narrowest forehead breadth gives a great difference between the Bontoc and lowland groups. The Bontoc, with the narrowest head, has the widest forehead, and the Lowland with a wider head, has the narrowest. The women have relatively wider foreheads than the men. The forehead of the Igorots is wider than that of the inhabitants of the Malay Peninsula, or of other Malays, as wide as the Northern Chinese, and a little less wide than the Aino(39).

Widest head breadth compared with narrowest forehead.

Group	Widest part of head	Narrowest part of forehead.	Difference
Bontoc	14.5	10.5	4.0
Highland	14.7	10.3	4.4
Lowland	14.9	10.25	4.65
Total	14.6	10.3	4.0
Women	14.3	10.3	4.0

IV. PHYSIOGNOMY.

The morphologic face height is the distance from the chin to the nasion; and the physiognomic face height is from the chin to the hair line. The dimensions are practically the same for the Bontoc and highland groups, but the lowland group is smaller in every particular. The face width of the Bontoc and Highland is greater than that of the inhabitants of the Malay Peninsula, and is nearer that of the Chinese, Japanese, and Ainos. The physiognomy of the women is less in its dimensions than that of the men.

Dimensions of the face.

Group.	Number.	Physiognomic face height.	Morphologic face height.	Bizygomatic width.	Physiognomic index.	Morphologic index.
Bontoc	14	18.1	10.8	13.[illegible]	[illegible].7	78.8
Highland	46	18.1	10.9	13.8	76.3	79.0
Lowland	44	17.5	10.7	13.3	76.0	80.4
Total	104	17.9	10.8	13.6	76.0	79.4
Women	10	16.6	10.3	13.1	79.0	78.6

The index of the physiognomy, which indicates the relative face width, is greatest for the mountain division and least for the Bontoc. It is greater for the Igorots than for the Japanese and Malays, but it is less than that of the Aino. The women's faces are relatively wider than the men's. The morphologic index which indicates the relative length of the face below the eyes is greatest for the Lowland and least for the Bontoc. It is less than that of any other Eastern Asiatic peoples, although the Mantra(40) are about the same.

The lower face height (chin to nasal septum) as compared with the artistic modulus and with the total head height (chin to vertex) is as follows:

Lower face height compared with the artistic modulus and total head height.

Group.	Number.	Total head height.	Artistic modulus.	Lower face height.	Relative lower face height to total head height.
Bontoc	14	21.8	7.3	6.7	.31
Highland	46	22.0	7.0	6.6	.30
Lowland	44	21.1	7.1	6.7	.32
Total	104	21.6	7.1	6.7	.31
Women	10	20.7	7.1	6.5	.31

The Highland has the least lower face, the Lowland the greatest, and the Bontoc and the women are exactly intermediate. The Highland has the greatest total head height, the longest physiognomy, and the shortest lower face, therefore his frontal cranial height is the greatest of all the Igorots. This is true also of the auricular bregmatic height, and the head outlines show the same, therefore the several measurements corroborate each other. The artistic modulus of the Bontoc is nearer that of the Europeans than are the others.

NOSE.

The nasal dimensions considered with those of the mouth are given in the following table:

Nasal and oral measurements on the living.

Group.	Number.	Nose, length.	Nostril, breadth.	Nasal index.	Number.	Mouth, length.	Lip, width	Mouth, length.[a]	
Bontoc	14	4.1	4.0	97.6	6	4.1	1.1	Chinese	4.7
Highland	46	4.3	3.8	88.4	35	4.8	1.2	Parisian ♂	5.0
Lowland	44	4.0	3.8	95.0	28	4.9	1.2	Parisian ♀	4.7
Total	104	4.1	3.8	92.7	69	4.8	1.2	Negro	5.31
Women	10	3.8	3.8	100.0	10	4.1	1.1	Negress	5.1
Bontoc (Jenks 19)	32	5.3	4.2	79.2					

[a] Topinard (3).

The measurements of the mouth may be dismissed by stating that the lips of the Igorots are full, but not thick and protruding like those of the Negro, nor is the mouth so large. The Bontoc and the women have smaller mouths than the Highland and Lowland Igorots.

The height of the nose measured from the subnasal point to the nasion is 7 millimeters less than the average height of this feature of the inhabitants of the Malay Peninsula (41), and the breadth (*ala nasi*) is the same, whereas the height and breadth are but 2 millimeters less than that given by Annandale and Robinson (43) for the same people. The resulting nasal index is therefore 10 per cent greater than Martin's for the Malay Peninsula and about the same as that of Annandale and Robinson (1). The extremes of nasal index found are 72 and 115.[a]

The women of the Malay Peninsula have narrower noses than the men, while the Igorot women have wider.

It may be of interest to note that the nasal index of the dolichocephalic Lowland Igorots is 99.4, while that of the brachycephalic is 85. This would seem to indicate that there are two types of Igorots in the lowlands, the long headed being wide nosed, the broad headed not to such a degree.

EYES.

The eyes are measured by taking the distance between the inner corners (*commissura palpebrarum medialis*) and between the outer corners (*commissura palpebrarum lateralis*) at the junction of the lids.

[a] Cunningham (11) gives the nasal index of 23 Australians (native males) which "are ranged in the immediate vicinity of 94" with extremes of 79 and 104. This at once suggests a relationship between the Australian aboriginal and the Igorot.

Eye measurements.

Group	Number.	Inner.	Outer.	Eye width.
Bontoc	14	3.60	9.20	2.80
Highland	46	3.30	9.20	3.10
Lowland	14	3.35	9.05	2.85
Total	101	3.40	9.10	2.85
Women	10	3.30	8.80	2.75

Eye width.*	
Parisians	2.75
Belgians	3.00
Chinese	3.20
Australians	3.34
Negroes (Africa)	3.38

* Topinard(64)

The eyes of the Bontoc are the narrowest and they are also more widely separated than those of the others(70). Those of the highland group are the widest and they are also the closest together, while the lowland is between the other two in eye width and the inter-eye distance. The eyes of the women are narrower than those of the men, but the same distance apart as the group to which they belong.

The artistic conception of the European eye is that it should be equal in width to the distance between the two eyes, and the artists add that the mouth should be one and one-half times the eye in width of opening. The Igorots have a smaller mouth and greater distance between the eyes than the artistic ideal for the European(63).

FACIAL ANGLE.

The facial angle is determined directly with two brass bars bolted together at one end. One bar is placed in line with the external auditory meatus, the other with the glabella, and the apex of the triangle is opposite the point covering the junction of the nasal septum and the upper lip (subnasal point). This is not so accurate as the facial angle of the skull, and minor differences are not to be detected by this method, but it affords an approximate angle with ease and facility.

The facial angle of the Bontoc Igorots is not measured, but that of the Highland and Lowland Igorots is given with that of the women and of the boys.

Facial angle.

Group.	Number.	Facial angle.
Bontoc	0	0
Highland	42	78°
Lowland	17	77°
Total	59	77°.5
Women	10	80°
Boys 5	2	86°
Boys 6–10	3	78°
Boys 11–12	5	76°
Boys 13–14	5	79°
Boys 15–16	6	73°

Cephalic index.	Per cent.	Facial angle (per cent). 65° to 70°	71° to 75°	76° to 80°	81° to 85°	86° to 90°
Dolichocephalic	24	0	25	46	29	0
Mesocephalic	48	2	40	33	21	4
Brachycephalic	10	10	30	50	10	0

The Highland and Lowland Igorots have practically the same angle, while that of the women is greater. The angle decreases with age, for example: Four boys below the age of 10 have an angle above 80°, after this age it is below 80°.

When compared with the cephalic index prognathism becomes evident among the brachycephalic, while the dolichocephalic are less prognathous and the mesocephalic are clearly mixed. The brachycephalic resemble the Negrito in their prognathism.

MALAY AGAINST IGOROT.

Four indices which are considered to be important in type differentiation may be compared with the same figures of the inhabitants of the Malay Peninsula(44). The cephalic index $\left(\frac{\text{breadth}}{\text{length}}\right)$ will be taken first, because it is the most important.

Comparison of cephalic indices of Igorot and Malay.

Group.	Index.	Group.	Index.
Bontoc	77.1	Blandas	77.1
Highland	77.8	Semang	77.9
Lowland	78.5	Reine Senoi	78.5
		Besisi	82.4

The exactness with which the Bontoc and Blandas, the Highland and Semang, and the Lowland and "Reine Senoi" correspond is remarkable. The similarity between the Igorots and the inhabitants of the Malay Peninsula is so exact that if cephalic index is the criterion of type, the conclusion must be that they are identical types of people.

The height index of the head is given next, because it is closely associated with the cephalic index.

Comparison of height indices of Igorot and Malay.

Group.	Index.	Group.	Index.
Bontoc	70.0	Blandas	64.6
Highland	70.4	Semang	65.5
Lowland	68.3	Reine Senoi	67.0
		Besisi	68.0

The correlation of head height is almost reverse in its relation to the horizontal diameters (cephalic index). Could the low headed dolichocephals be eliminated from the lowland group, the index would be raised higher than the highland, and the groups of Igorots would then

correspond with those of the Malay Peninsula, excepting that the Igorot head is higher.

The morphologic face index is correlated below:

Comparison of the morphologic face indices of Igorot and Malay.

Group.	Index.	Group.	Index.
Bontoc	78.8	Blandas	81.6
Highland	79.0	Semang	82.1
Lowland	80.4	Reine Senoi	82.1
		Besisi	81.8

Martin's groups have longer faces below the eyes than the Igorots. The lowland is more like the Reine Senoi than are the Bontoc and highland groups, which diverge from the other Malays. This may be explained on the assumption that the Bontoc and highland groups have greater European intermixture.

Finally the nasal index is correlated as follows:

Comparison of the nasal indices of Igorot and Malay.

Group.	Index.	Group.	Index.
Bontoc	97.6	Blandas	76.6
Highland	88.4	Semang	83.5
Lowland	95.0	Reine Senoi	87
		Besisi	76.9

The disparity between the groups is marked. Again, if the type of dolichocephalic Igorots with very wide noses be eliminated, the disparity is diminished.

The Malays of the inland part of the peninsula according to Martin are mesocephalic with one group brachycephalic; hypsi to orthocephalic; brachyfacial to mesofacial; and mesorhinian to platyrhinian. The Igorots are mesocephalic and dolichocephalic; hypsicephalic; brachyfacial; and platyrhine. They are also slightly prognathous.

V. DESCRIPTIVE CHARACTERS.

The skin of the Igorot is characteristically light brown, but the tint varies with individuals and it is different in different families(72, 73). The influence of light and shade may be noticed: those who work in the sun are darker than those who serve in the house and the women and the children are lighter than the men. The whole family of one chief, including several young men and women who stay indoors a great deal is so light brown in color as to be classed as yellow. In a few individuals

a tinge of red may be seen, or the face appears bronzed, some Igorots strikingly resembling the North American Indian. The coloring shows a trend towards lightness rather than the reverse, and this is manifested most strongly among the Bontocs.

Skin color (per cent).

Group.	Number.	Golden-brown.	Light brown.	Brown.	Dark brown.
Bontoc	12		30	60	5
Highland	45	5	11	71	13
Lowland	35	2	8	83	8
Total	92	3	13	71	11

The relative number of brown individuals increases in the Highland and reaches its limit in the Lowland. The lightest colored individuals are found in the highlands. The one golden-brown individual of the lowlands is a young man who for several years has been a servant in an American family, where he worked principally indoors and wore the regular European clothes of the Tropics.

The hair is invariably black, straight, and coarse. A few individuals with wavy hair were observed, but not one of those measured had a noticeable wave in the hair. This is remarkable when one considers how closely the Igorot resembles the Negrito in other characters. I can account for the predominance of the straight hair in one way only—it is dominant to the kinky hair of the Negrito, and in the course of centuries the kink has disappeared leaving only an occasional trace, such as the few wavy haired individuals I observed casually, and those noticed by Jenks[20] among the Bontoc Igorots[71]. The wavy haired individuals probably belong to the Senoi type of Martin.

The brows of the Igorots are never so beetling, and the brow ridges never so prominent as among the Filipinos of the coasts and other parts of the Islands. However, there is a slight difference of the size of the superciliary ridges among the Igorots which may be presented in three groups, small, medium, and large.

Brow ridges (per cent).

Group.	Number.	Small.	Medium.	Large
Bontoc	10	20	70	10
Highland	45	11	42	47
Lowland	42	16	65	19
Women	10	70	30	

The brows of the highland group stand out clearly, because they are larger than those of the other two groups, and the brows of the women are small, as is to be expected.

The Igorot nose may be divided into three classes by the profile view—aquiline, straight, and australoid. With the side may be coupled the front view, in which two factors claim attention, the direction of the nostril openings, and the amount of flare to the alæ of the nostrils. Each of these characters has three qualities which may be combined with the three of the profile to make up three composite types. The aquiline nose has narrow nostrils that open downward and the nasal index is low. The straight nose has wider nostrils that open downward and forward, and the nose is compact without extremely flaring nostrils. The australoid nose has wide flaring nostrils that open almost forward and the nasal index is high, the nose extremely platyrhine.

Types of nose (per cent).

Group	Number.	Aquiline.	Straight.	Australoid.
Bontoc	5	0	80	20
Highland	46	16	28	56
Lowland	32	6	22	72
Total	83	12	36	58
Women	10	10	70	20

Of these three types, the aquiline is found most frequently among the Highland Igorots, the straight among the Bontoc, and the australoid among the Lowland. The nose of the women is usually straight or australoid. [Plates II, III, and IV.]

HEAD OUTLINES.

The head outlines are treated as composites in groups, according to cephalic index and by locality. Only the sagittal outlines are utilized because they are more accurate than the other, and illustrate more distinctive differences.

The composites are made by drawing each outline on transparent paper with the mid-point of the line which connects the glabella and the occipital tubercle, as well as the line itself, superimposed upon the same point and line for each drawing. After all the outlines of one group are drawn in this way the heaviest line is reproduced as the composite on another sheet of paper.

The composites grouped according to cephalic index indicate what is to be expected from von Török's classification, namely, the dolichoce-

phalic heads are the largest and the brachycephalic the smallest, while the mesocephalic are intermediate in size. (Fig. 3.) The composite

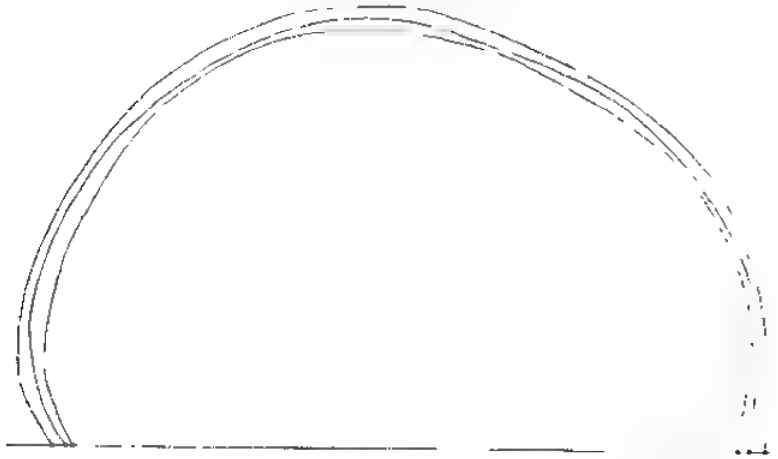


FIG. 3.—Composite sagittal outlines of 104 Igorots: 41 dolichocephalic, largest outline; 43 mesocephalic, intermediate outline; 18 brachycephalic, smallest outline.

curves of the three groups are similar. The forehead of the brachycephalic protrudes slightly and the occipito-parietal region is somewhat flattened.

When the composite dolichocephalic head outline of the Igorots is compared with a similar outline from an equal number of negroes I measured in Baltimore at the Johns Hopkins Hospital Dispensary in 1906, the data being as yet unpublished, and an equal number of white students of the University of Michigan I measured at Ann Arbor in 1905 to 1907(4), some striking differences may be seen. (Fig. 4.) The head of the Igorot is the tallest and shortest of the three,

FIG. 4.—Composite sagittal outlines of the dolichocephalic heads of Igorots, negroes, and white students: Igorot, the short, high outline; white, the long, low outline; negro, the broken outline.

whereas that of the white student is the lowest and longest. The forehead of the negro is low and receding, while that of the Igorot and white student are high and prominent. The head region immediately above the somasthetic area

of the brain is prominent in the Igorot and in the negro, but not in the white student. The white student has a relatively large frontal region, the negro has a relatively large body sense and motor region, while the Igorot has both. The Igorot represents a protomorph, or a mixture, while the negro and the white student represent specialized products of evolution, or definite types. The Igorot contains elements similar to each of the others, at least this is true of the dolichocephalic.

The brachycephalic head outlines reveal somewhat different characteristics. (Fig. 5.) The white student is again the longest, but it is also the tallest, the

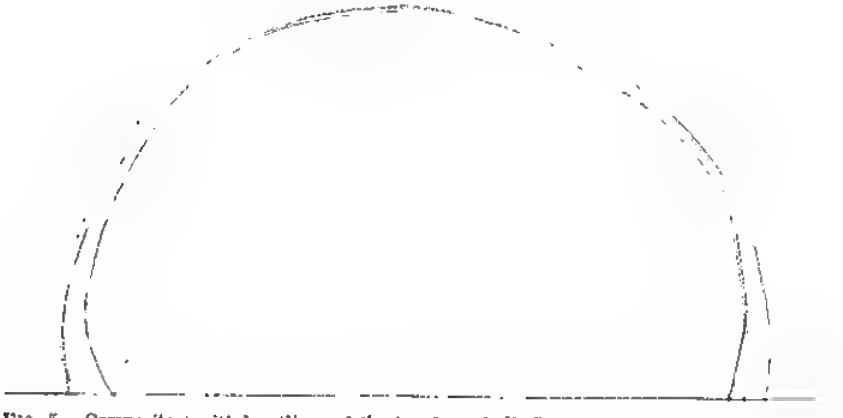


FIG. 5.—Composite sagittal outlines of the brachycephalic Igorots, brachycephalic negroes, and brachycephalic white students: Igorot, the inner solid outline; white, the outer solid outline; negro, the broken line.

Igorot has a rounded outline with full, high forehead and the negro has a bombé forehead high in the frontal region. There are only 6 brachycephalic negro head outlines and the composite for that reason is not a representative one.

The mesocephalic head outlines represent more definitely than the dolichocephalic the important differences denoted by the latter. (Fig. 6.) The Igorot

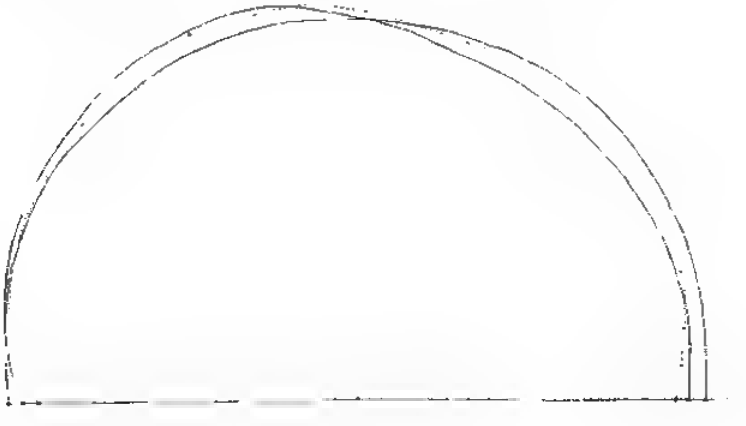


FIG. 6.—Composite sagittal outlines of the mesocephalic Igorots, mesocephalic negroes and mesocephalic white students: Igorot, the broken outline; white, the long, solid outline; negro, the short, solid outline.

head outline is an exact blend of the white student and the negro, except that it is shorter and slightly higher. The white student's head is relatively large frontally, the negro's is relatively large parietally, and the Igorot's is relatively well developed throughout.

The sagittal outlines of the 10 Igorot women of Atoc when compared with similar outlines of 10 women students at the University of Michigan selected with the same cephalic index show great dissimilarity. (Fig. 7.) The white

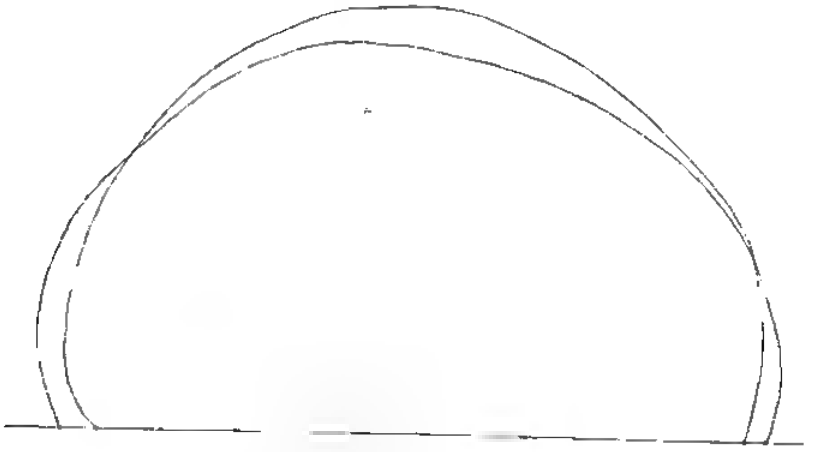


FIG. 7.—Composite sagittal outlines of the heads of 10 Igorot women and 10 American college women. Igorot, short, high outline; American, long, low outline.

student head is longer, the Igorot head is shorter and higher, and both are depressed beneath the occipital and frontal regions. The somesthetic region of the Igorot is protuberant, while that of the white student is unobtrusive. The small number of individuals and the difficulty with the long hair of the women vitiate the records somewhat, but the differences in height and length are of the same nature as in the men, although intensified in the women.

The distinguishing differences between the Igorot and the American student are the length and height of the head. The Igorot's is short and high, the American student's is long and low. The Igorots, male and female, carry heavy burdens by straps across the top of the head, which may influence the height of the head from compensatory hypertrophy following the continual stimulus of great pressure. The generous muscular development of the Igorot may also have some influence in heightening the head, by increasing the size of the somesthetic area of the brain.

The head height is a racial trait, as well, which may be inferred by comparing the sagittal outlines of the three groups of Igorots. (Fig. 8.) The Highland Igorots have longer, higher heads than the Lowland Igorots. The Bontoc head is longer than the others, but not so high as the Highland. This is an additional differentiating fact between the three groups, and again the Bontoc is more nearly like the white, whereas the Lowland is less so than the others.

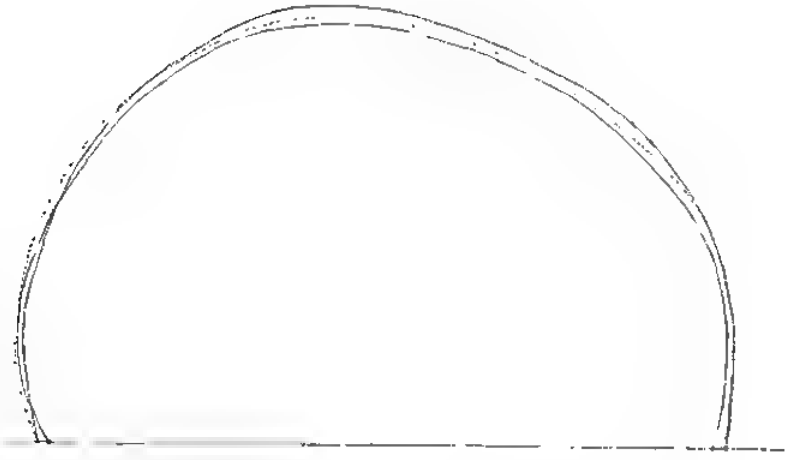


FIG. 8.—Composite sagittal outlines of the three groups of Igorots: Bontoc, the broken outline; Highland, the large solid outline; Lowland, the small solid outline.

EARS

The ear of the Igorot is a most typical feature and a true racial character. Not all the ears are alike, indeed there are at least three well-defined forms, and many variations of the three. The typical Igorot ear is found oftener than any other kind, and its frequent presence merits a special description and portrayal by photograph. (Plate V.)

The typical Igorot ear is large and long and somewhat rectangular in shape. The superior border of the helix is smooth, thin, gracefully rounded, and the posterior border is straight. The anthelix circumscribes the concha in the shape of a large oval with its apex at the *incisura interhugica*. The lobule is square and flat, the inferior border usually joining the cheek at right angles. The ear does not stand out from the head, neither is it pressed close to it, but occupies an intermediate place and is beautiful and graceful in both form and position. (Plate VI.)

There is not a line or character about the Igorot ear to relate it with the anthropoid apes nor with any of the primitive people of the world, so far as I am able to judge. It is not like the Negrito ear, which is short and round, the helix of which passes horizontally backward from the superior end of the ear, the anthelix forming a roll that often gives the ear the appearance of having a double helix, and the lobule is round or pointed. (Plates VII and VIII.) It has none of the characteristics of the Australian aboriginal ear[51] which is similar in many ways to the anthropoid. Darwin's tubercle is present more frequently in the men than in the women, which is true of Europeans[52]. I have seen ears resembling the Igorots on Spaniards, Englishmen, and

Americans, but I shall discuss that subject fully in a forthcoming article on Filipino ears. The ear is a European one, and characteristic of one of the finer types of Europeans.

The other types of ears among the Igorots resemble the Negrito, and the Malay or Chinese ear without lobule. Three types of ears may be distinguished, which are distributed as follows:

Types of ears.

Group.	Number.	Typical	Oval, no lobule.	Round.
Bontoc	12	9	2	1
Highland	45	29	12	4
Lowland	34	20	6	8
Total	91	58	20	13
Women	10	9	1	0
Boys	27	20	3	4

The Bontoc Igorots have a relatively larger number of typical ears than the other groups, although the Highland Igorots have almost as great a relative number, but the Lowland have the least, and also a greater number of round ears (Negrito?).

The ear index of Topinard (65) is useful in differentiating the types, but Schwalbe's morphological index was not utilized. The ear index is the $\frac{\text{greatest breadth} \times 100}{\text{greatest length}}$

Ear measurements.

Group.	Number.	Breadth.	Length	Ear index.
Bontoc	12	33.1	57.2	57.8
Highland	46	31.9	59.3	53.8
Lowland	44	31.4	56.7	55.3
Total	101	31.8	57.9	55.0
Women	10	28.8	49.7	57.9

Ear index (Topinard)		
Type.	Number	Index.
Europeans	8	54.0
Melanesians	8	59.*
Polynesians	8	60.0
Negroes (African)	18	61.2

The Highland Igorots have the longest ears and the lowest index, with the Bontoc second and the Lowland third in ear length, but the Lowland index is less than the Bontoc. The ear index is not an absolutely reliable indication of ear type, but with the aid of descriptions it is serviceable. The index of the typical Igorot ear is low because the ear is long and not round. The ear should be one of the best marks to determine the nature of heredity, because it is not subject to sexual selection in the way that other features such as the eyes or nose may be,

and there is no reason to believe that natural selection would affect it. For the same reasons this feature should be one of the best marks to determine racial purity.

The ear marks of a people may be significant.

CORRELATIONS.

The correlation of cephalic index and stature is determined by averages and percentages. The average stature of the dolichocephalic Igorots is 157.1 centimeters, that of the mesocephalic is 155.2, whereas the stature of the brachycephalic is only 152.2 centimeters.

Correlation of cephalic index and stature (per cent).

Index.	Stature below 150 centimeters.	Stature 150 to 160 centimeters.	Stature above 160 centimeters.
Dolichocephalic	16.6	64.5	19.1
Mesocephalic	20.0	62.5	17.5
Brachycephalic	31.8	51.0	18.7

There is a greater proportion of comparatively tall individuals among the dolichocephalic Igorots, and a greater of small individuals among the brachycephalic than among the mesocephalic, but the difference between the mesocephalic and brachycephalic is greater than that between the mesocephalic and dolichocephalic. A larger per cent of each index is found between 150 and 160 centimeters, which is to be expected in a much mixed, endogamous people. However, it is in the extremes that aboriginal types are to be searched for, and it is the extremes where the differences are greatest.

The correlation of cephalic index and relative arm length is not so great as the correlation of cephalic index and height, but it is in the same direction. The long head and the tall height are parallel and so are the long head and the relatively long arm. However, the correlation is slight.

Correlation of cephalic index and relative arm length (per cent).

Groups	Below 43.0 centimeters.	Between 43.0 and 45.5 centimeters.	Above 45.5 centimeters.
Dolichocephalic	14.2	64.4	21.4
Brachycephalic	20.3	52.3	21.0
Mesocephalic	31.0	54.8	14.2

The average relative arm length is 44.3 for the dolichocephalic, 44.2 for the brachycephalic, and 43.0 for the mesocephalic. In groups above 45.5 there are 21.4 per cent dolichocephalic, 21 per cent brachycephalic, and 14.2 per cent mesocephalic. In groups below 43.0 there are 14.2 dolichocephalic, 26.3 brachycephalic, and 31 mesocephalic.

The dolichocephalic have relatively longer arms than the mesocephalic, while the brachycephalic have an intermediate relative arm length.

Correlation of stature and relative arm length (per cent).

Stature.	Below 43.0 centimeters.	43.0 to 45.5 centimeters.	Above 45.5 centimeters
Above 160 centimeters	9	82	9
150 to 160 centimeters	23.3	53.4	23.3
Below 150 centimeters	38	47.6	14.4

There is a progressive increase of relatively short arms (below 43) from absolute tallness to absolute smallness, and a progressive increase of arms of relatively intermediate length (43 to 45.5) in the opposite direction, while the number of long arms (above 45.5) increases from tallness, through smallness, to medium size in stature. Continuing the analysis of cephalic index combined with stature and relative arm length a table is presented as follows:

Analysis of cephalic index combined with stature and relative arm length (per cent).

Stature and group.	Below 43.0 centimeters.	43.0 to 45.5 centimeters.	Above 45.5 centimeters
Above 160 centimeters:			
Dolichocephalic	0	100.0	0.0
Mesocephalic	12.5	62.5	25.0
Brachycephalic	20.0	80.0	0.0
150 to 160 centimeters:			
Dolichocephalic	14.8	55.6	29.6
Mesocephalic	30.4	56.6	13.0
Brachycephalic	30.0	40.0	30.0
Below 150 centimeters:			
Dolichocephalic	33.3	50.0	16.6
Mesocephalic	50.0	40.0	10.0
Brachycephalic	20.0	60.0	20.0

The Igorots may be divided into four groups by the above correlations:

1. Tall dolichocephalic Igorots with long arms.
2. Small dolichocephalic Igorots with short arms.
3. Mixed mesocephalic Igorots.
4. Brachycephalic Igorots with intermediate arm length.

The correlations and differences suggest that three steps of racial mixture preceded present conditions. First, a small dolichocephalic

people with relatively short arms and a brachycephalic people mingled and partly fused. They were then joined by a tall, dolichocephalic, long-armed people already partly fused with the brachycephalic, and subsequent fusion was again altered by contact with the brachycephalic people. The last contact was quite recent and the brachycephalic people are more distinct as a type than either the tall dolichocephalic or the small dolichocephalic, and they are also present in greater number.

VI. SOMATOLOGIC RACE TYPES.

Stratz(56) divides mankind into three groups, *protomorphs* or nature folk, *archimorphs* or highly differentiated peoples, and *metamorphs* or mixed races. These may be used in connection with the canon of Fritsch and the artistic modulus(24) as comparative standards.

The canon of Fritsch takes as its standard the length of the vertebral column and the other body measurements are compared with this(57). The length of the vertebral column is equal to the distance from the *symphysis pubis* to the nasal spine. With this basis, photometry may be made an adjunct of anthropometry when interpreting the length relations of the body parts. The artistic modulus is the total head height from chin to vertex, and it is used in relation to stature. The modulus of Geyer, which is the stature equal to 8 total head heights, is the artistic ideal for the European.

With this explanation the following classification is given.

The protomorphs comprise the Australian, Papuan, Hottentot, American Indian, Eskimo, Philippine Negrito, and the Pigmy of Africa.

The archimorphs are the leukoderm or white, the melanoderm or black and the xanthoderm or yellow men.

The metamorphs are mixtures of the other groups, and are found along the zones between the black, white, and yellow races: in northern Africa, eastern and southern Asia and in the islands of the Pacific.

The protomorphs are short in stature with relatively long total head height, which is in the lower face and not in the cranium, and their arms are relatively long. They conform to the canon of Fritsch except in the relative length of arm, and to the artistic canon except in the relatively large head.

The melanoderms are relatively short in stature, long in arm, and short in upper head height, nasal spine to vertex.

The xanthoderms are relative short in stature, in length of leg and in upper head height. A slight departure from this may be noted in the females of each group. A table of individual records among which are three Igorot men, is shown for comparison. (Table VIII.)

A more intricate and detailed comparison, as in the accompanying charts, reveals some noteworthy differences between the three Igorots shown by fig. 9. The first [No. 60] is tall and dolichocephalic; the second [No. 3] is intermediate in height and mesocephalic; while the third [No. 83] is small and brachycephalic. Other distinguishing characters are to be noted, such as the almost uniform conformity of No. 60 to the canon of Fritsch and the modulus of Geyer, although the body is slightly longer and the legs slightly shorter than the European,

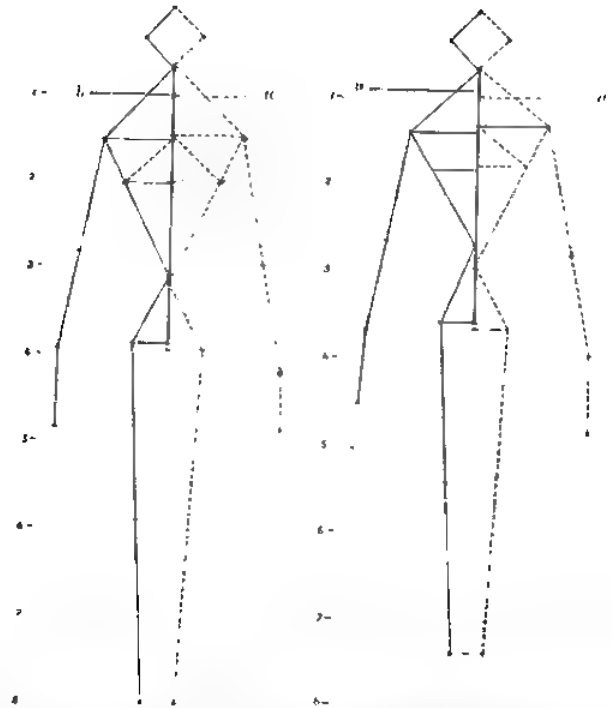


FIG. 9.—The solid lines are Europeans, the broken lines Igorots. The figure on the left represents an Igorot man (No. 80), stature 168 centimeters, from the highlands. The middle figure represents an Igorot man (No. 3), stature 155 centimeters, from Bontoc. The figure on the right represents an Igorot man (No. 53), stature 142 centimeters, from the lowlands. The left half of each figure (solid lines) is the European standard male canon of Fritsch, modified to the Igorot stature, and the right half of the figure (broken lines) is the Igorot canon of Fritsch. The horizontal lines numbered 1 to 8 indicate the number of total head heights in the Igorot's stature according to the artistic modulus of Geyer. The lines *a* and *b* point to the chin.

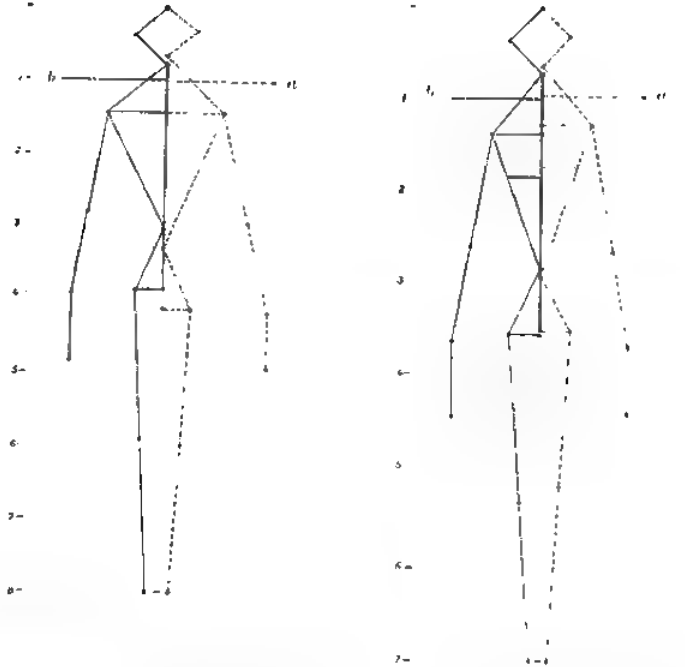


FIG. 10.—The left side of the figure (solid lines) is Merkel's standard female European according to the canon of Fritsch, and on the right side (dotted lines) is a typical Igorot (No. 52) according to the same canon. *a* and *b* point to the chin.

and the upper arm is longer and the hand shorter. No. 3 presents relations of body parts similar to the protomorphs. The body length is only 7.4 times the total head height, and the greater part of the latter is in the lower face. The arm is considerably longer than that of the European, the body is also longer, while the umbilicus is notably lower in this type. The chief characteristics of No. 83 are long body, short legs and short upper head height. The characters which the three Igorots have in common and in which they are different from the canon of Fritsch are long bodies, short legs, long arms, short necks, long lower head height, and short upper head height. The tall Igorot is most like a white man in all these characters and the small Igorot is least like him.

When a typical Igorot (No. 52) is compared with Merkel's normal woman's figure[57] it is noticed that there is no great disparity between the two. (Fig. 10.) The neck and the upper head of the woman are longer than those of the Igorot, while the body and legs of the Igorot are slightly longer than those of the woman. The abdomen (waist) of the woman is longer, the umbilicus higher than in the Igorot.

There may be then, three or more types of Igorots, representing three or more fundamentally different groups of mankind, and these three have fused in part and remained separate in part. An average individual Igorot resembles in form the woman of Europe, and represents a protomorph of the nature folk.

Consider the average Igorot stature, leg length, and arm length in relation to the classification of Stratz, and some incongruity is apparent. The average relative arm length of the xanthoderm and of the Igorot is 44.0, while that of the protomorph is 47.2. The average relative length of the leg is 51.6 for the Igorot, 52.0 for the protomorph, and 46.4 for the xanthoderm. The Igorot arm is short, like that of the xanthoderm, and the Igorot leg is long, like that of the protomorph. This indicates that the Igorot has elements of both the protomorph and the xanthoderm if we accept Stratz's classification, or if not, it at least indicates a relationship between the Igorot, the protomorph, and the xanthoderm. Similar elementary characters enter into the composition of each people. Stratz's classification may be misleading in that his types are too simple, yet do not represent fundamental units of structure, but they may be useful in showing general relationships that exist at present. The xanthoderm, represented by the Chinese and Japanese, is more nearly like the group of Igorots that resemble the European, and the resemblance of Igorot to xanthoderm may be due to a European mixture in each. On the other hand the reason for the resemblance of the Igorots and the protomorph may be that each has the same fundamental type represented in its make up. The Igorots that resemble the protomorph are those which are most like the Negrito. Here may lie the secret of the whole matter. The Negrito or pigmy forms the substratum of the East, on which are engrafted in devious ways and varying proportions

some of the early types of Europe, and the many different peoples of the East are the results of this varying mixture. This seems too simple to be plausible, but the deeper the study the greater the revelations of its truth. The type of Igorot that resembles the Negrito is not a protomorph but has protomorphic characters. Another type of Igorot that is similar to Martin's Senoi also has protomorphic characters, but they are unlike those of the Negrito. The individual Igorot that resembles a true protomorph (No. 3) is an intermediate type, unlike either the Senoi or the Negrito. The protomorph is not a true type, but a composite or blend of other more distinct types. The Senoi itself is not a pure type, but is mixed, as may be readily demonstrated.

Judged by the canon of Fritsch and the artistic modulus of Geyer according to the classification of Stratz, the Igorot has characters of the protomorph, the xanthoderm, and the leukoderm; does not resemble the melanoderm, but is in reality a metamorph. The protomorph characters are due to the Negrito, the xanthoderm to a type found among Chinese and Japanese, but of European origin, the leukoderm characters to another European type.

VII. THREE SELECTED TYPES.

When the 104 adult male Igorots are separated into the three groups, dolichocephalic, mesocephalic, and brachycephalic, and these groups are subdivided according to the shape of the head outlines, three types, 2 dolichocephalic and 1 brachycephalic, are separated with ease. (Figs. 11 and 12.) The remainder could be subdivided with difficulty, and they

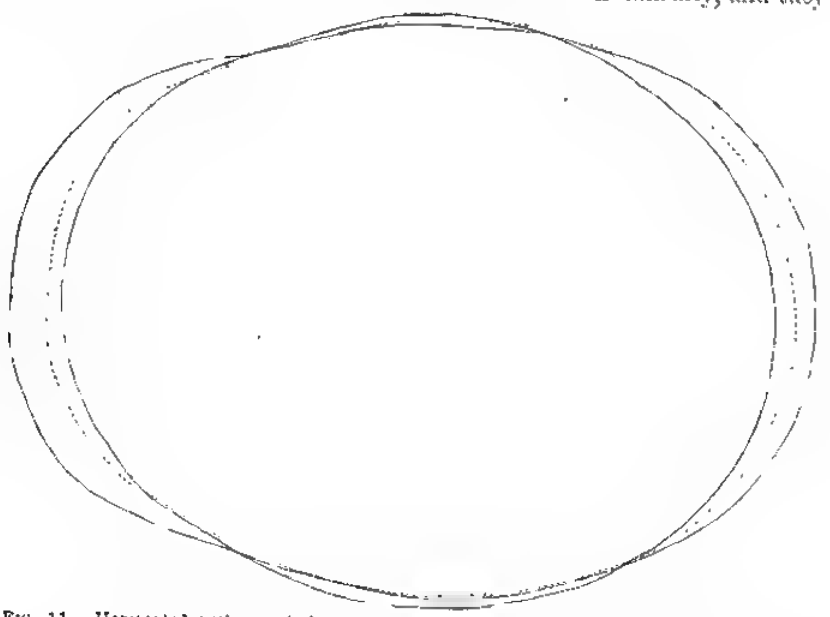


FIG. 11.—Horizontal outlines of three Igorot heads to represent the three selected types M, A, and N; M, the long outside outline (solid); A, the broken outline; N, the short inside solid outline.

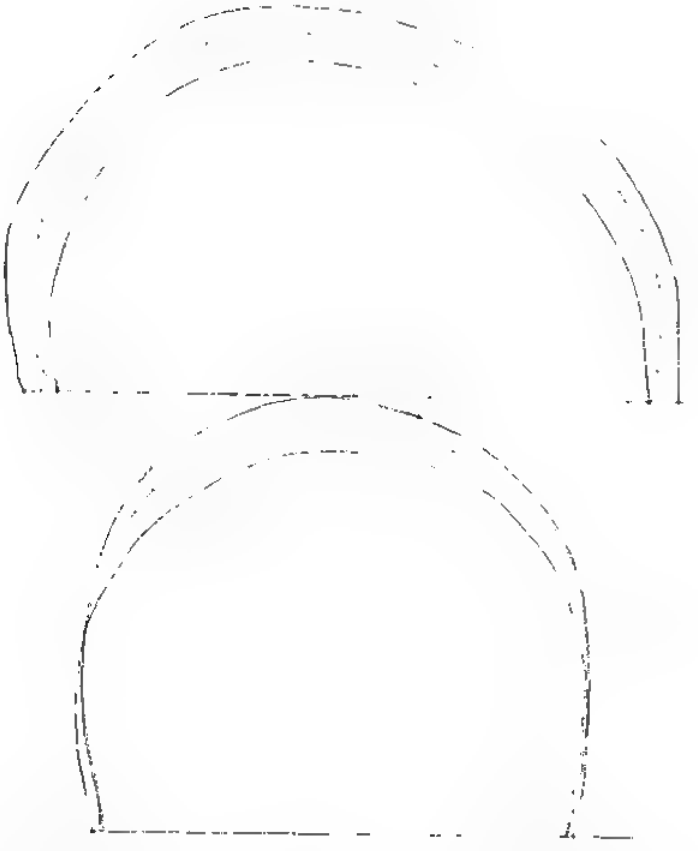


FIG. 12.—Sagittal and coronal outlines of three Igorot heads to represent the three selected types: M, the outside solid outline, A, the broken outline, N, the inner solid outline.

are not so treated because the individuals resemble one or the other of the three types, into which they shade insensibly.

The dolichocephalic type M has a long, narrow, high, square head. The dolichocephalic type A has a long, low, oval head with flat top that slopes gently forward. The occiput and forehead bulge slightly. The head of the brachycephalic type N is low and round, and the forehead is receding. Other descriptive characters are as follows:

Character.	Type M.	Type A.	Type N.
Hair	Straight coarse black	Straight coarse black	Straight coarse black.
Skin	Golden-brown	Brown	Brown.
Brows	Heavy	Medium heavy	Medium slight.
Nose	Straight slightly aquiline	Large semi-australoid	Short semi-australoid.
Ears	Typical Igorot	Oval no lobule	Oval or round.
Frontal angle	78.7	77.7	75.7.
Occupation	Petty chiefs and councilors	Laborers, 1 policeman	Day laborers.
Residence	Bontoc and Highland largely	All 3 regions	Lowlands largely.

The letters M, A, N, are selected for obvious reasons. I believe the three represent a type of the Malay, the Aboriginal of the East, and the Negrito.

In addition to the descriptive characters, the measured ones are given in averages and indices, or relative factors. (Table IX.) The characters in which the three types resemble each other are nasal index, hair, relative shoulder width, eye width, relative leg length and relative hand length, and it may be said that these characters are more representative of the Igorots than any other, unless it be eye color which is so uniformly brown in all Igorots, that no records are made. The differentiating characters are chiefly stature, skin color, ears, head length, brachial index, cephalic index, total head height, relative lower face height, the distance between the eyes, and the position of the umbilicus. The types may be summarized as follows:

Type M.—The individuals of this type are petty chiefs, councilors, etc., who reside chiefly in Bontoc and the highlands of Benguet. They may be differentiated from other Igorots by their tallness and occasional light, golden brown skin, heavy brows, slightly aquiline nose, and large ears that have a square lobule, the lower border of which terminates abruptly against the corners of the mandible. Other distinguishing characters are the head length and height and the forehead width, which are greater than found in any other group of Igorots. The relatively long leg, small brachial index, and high umbilicus are characteristics to be emphasized. The cephalic index, nasal index, and ear index are the smallest found. Otherwise stated, the head, nose, and ears are longer and narrower than any others. The eyes are also farther apart, and the upper head is relatively higher than the lower face, which is broad, but not long.

Type A.—The members of this type are laborers (farmers, police, etc.) from all parts of Benguet and from Bontoc. Their differential descriptive characters are the unusually small stature, brown or dark brown skin, large, wide, flat australoid nose, rounded or oval ear without lobule, and the relatively broad shoulders. Their low, long, oval, flat-topped head with bombé forehead and narrow-eyes are distinctive. The arm and forearm are relatively short, and the brachial index is low.

Type N.—This type may be recognized readily by its small stature, brown skin, delicate brow ridges, small, round head with excessively developed parietal and temporal regions, narrow, retreating forehead, short nose, small round ears, and projecting jaws. The individuals of this type have relatively long arms and forearms, short hands, and a high brachial index. The cephalic index is high, the nasal index low and the ear index high. Especially to be noted are the low umbilicus close to the pubis, the relatively high total head height due to the large lower face, and the narrow space between the eyes.

There can be no doubt but that these three types are present among the Igorots, but what they represent is not so easy to decide. Type M resembles the European and it may be considered to be of European origin, recent or remote. Type N is in many respects like the Negrito, and is positively identified with the protomorphs of Stratz. Type A is intermediate between the other two in many characters, and in others it is nearly like one or the other, so that it may be only an intermediate

form, but if so it is none the less definite, and as much a distinct type as either of the others. I am inclined to believe that this is one of the primitive forms from which the Igorots are derived, because of the broad nose, short stature, and long, low head which associate this type with the australoid peoples.

It will be necessary to compare the average Igorot with the three selected types in order to determine to which the Igorot is more closely related.

The truest anthroponorphic characters should be contrasted to show this; therefore stature, cephalic index, nasal index, relative forearm length, brachial index, and omphalic index are selected for comparison.

Type	Stature	Cephalic index.	Nasal index.	Relative forearm	Brachial index.	Omphalic index.
M	164.5	74.4	96.0	14.4	74.6	48.4
A	146.6	75.1	97.7	14.2	75.1	39.0
N	150.3	84.3	89.4	14.8	80.0	40.9
Average, Igorot	154.0	78.0	92.7	14.4	76.9	41.1
Average, M, A, N.	153.8	77.9	94.4	14.5	76.6	41.1

The average Igorot resembles N more than M or A in stature, nasal index, and omphalic index, but is more like M and A in cephalic index, relative forearm length and brachial index, in which M and A are nearly alike. If M, A, and N each have had an equal influence in the composition of the average Igorot, then the average of the three should equal the average Igorot. If these two averages are different then the direction of the average M, A, N away from the average Igorot, and toward one or the other of the individual types, will indicate the direction of greatest influence. For instance, the average Igorot nasal index is 92.7 and the average nasal index of M, A, N is 94.4 which is nearer the nasal index of N than of M or of A. Therefore, the influence of N on the nasal index has been stronger than both of the other types. The same is not true of the stature, cephalic index and omphalic index for the averages are the same, hence the influence of each is equal. The influence of type N, however, has been greater than the other types in the relative forearm length and the brachial index. The average Igorot, therefore, has been molded in his makeup more by type N than by the others, at least in nasal index, relative forearm length, and brachial index.

Type N resembles the Negrito of the Philippines more closely than it resembles any other people and is clearly related to it, if not an actual prototype. The Negrito[48] is brachycephalic, type N is brachycephalic. The Negrito is platyrhine, type N is platyrhine. The Negrito has relatively long arms, type N has relatively long arms and forearms too. The average Negrito stature is less than 150 centimeters. That of type N is 149.5 centimeters. The hair of the Negrito is kinky, but that of type N is straight.

Type M is related to the European in so many ways as to leave no doubt of its origin.

Type A, with its long, low, flat head, broad face and wide, flaring

nostrils, its very small stature and low omphalic index represents not one type but two. Compared with Martin's Senoi it shows many similarities, and when the two are compared with type N, the Senoi appears as if it were a blend of type A and type N. In stature the Senoi is between A and N, but nearer the latter than the former.

Comparison of types A, Senoi I, and N.

Type.	Stature.	Cephalic index.	Nasal index.	Relative arm.	Relative leg.	Relative forearm.	Brachial index.
A	146.6	75.1	97.7	43.6	51.2	14.2	75.1
Senoi I	149.5	80.0	85.8	43.9	52.1	14.0	76.0
N	150.3	84.3	89.4	44.9	51.2	14.8	80.0

The cephalic index of the Senoi is exactly intermediate between the other two. The nasal index is less than either of the others, and is nearer N than A. The relative arm length of the Senoi is between the two, but nearer A than N. The relative leg length of the Senoi is greater than either of the others, but this may be due to a difference in methods of measurement. Martin used the pubic height and I the trochanter height. The relative forearm length of the Senoi is less than the other two, but the brachial index is in between and nearer A than N.

These standard measurements place the Senoi in a somewhat intermediate position between type A and the Negrito. The hair of the Senoi is frequently wavy, which is an additional indication of Negrito blood. The Senoi of Martin(42) has a characteristic Negrito ear. The position of the Senoi in the Malay Peninsula, between the Semang (Negrito) of the north and the Malay of the south would indicate that they represent a mixed race, the result of the blending of two others. Martin has unconsciously revealed a new race which is not the Senoi, but enters into their composition and is the same as type A.

Skeat and Blagden(54) find three races in the Malay Peninsula: Semang, classed as Negrito; Sakai, or Senoi who are dolichocephalic, wavy haired, and taller than the Semang, but have been modified by the Semang on one side and the Malay on the other, the latter people constituting the third race. The Sakai may be regarded as Dravidian, and so allied to the Veddahs of Ceylon, or as related to tribes in the interior of Camboge.

Martin associates the Senoi with the Veddahs, and the latter are closely related to the Igorots. The average stature of the Veddahs is 153.3, of the Igorots 154. The Veddahs are ortho-dolichocephalic, the Igorots, hypsi dolichocephalic. The nose and face of the Veddahs are not so wide as the Igorot's, and the arms are 47 per cent of the body length, while the Igorot's are but 44 per cent. The Veddahs have straight or wavy hair, while the Igorot hair is almost invariably straight, although an occasional wavy-haired individual may be found(71).

[3] Dr. Barrows, Director of Education, who has made an extensive and intensive study of the Filipino peoples, tells me that the three types described by Martin are to be found in different localities in the Philippine Islands, and represent the Negrito, the Malay, and a blend of the two.

P. W. Schmidt(51) compares the Indian, southeastern Asiatic (Mon Khmer Völker) and the inhabitants of the Malay Peninsula in physical characters and language, and concludes that the "Mon Khmer Völker" are intermediate between the others not only geographically but physically and philologically. The Indians are uniformly dolichocephalic, the Mon Khmer are dolichocephalic, mesocephalic and brachycephalic, and the Senoi are mesocephalic. The nasal index of the Indian is mesorhine and platyrhine, the Mon Khmer are leptorhine, the Senoi are mesorhine. The Indians are tall, the Senoi are small. The language, however, is the basis of Schmidt's argument that the "Mon Khmer Völker" represent a link between the people of India and Oceania, or as he expresses it: "ein Bindeglied zwischen Völkern Zentralasiens und Austronesiens." The works of Keane(21), of Risley, of Lapicque(28) and others support this view.

One may go even farther than this, and select European types that are represented throughout the East among the aborigines. Three or more primitive European types may be segregated among the Filipinos of almost any part of the Islands by careful selection, and at least two of these are represented among the Igorots, one in type M and the other in type A. In each type the European has crossed with the Negrito, and the result is two entirely different types.

The European represented by M was a medium sized, stockily built individual, with straight, heavy nose, long, square head, straight, black hair, and oblong ears. These traits have persisted with the alteration of skin-color, face and nose width, and stature due to the Negrito. The nearest living related type to this primitive European is the "big cerebellumed, box-headed Bavarian of Ranke"(6). This type is present largely in the Spanish population of the Philippines, the data on which I base this statement being reserved for future publication. Type M, or near relatives of it, may be found wherever the so-called Malay has settled and represents a distinctive Malayan type.

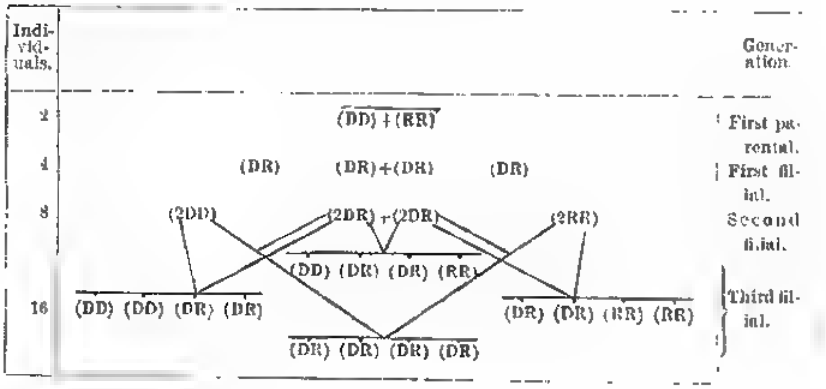
The European represented by A was a small individual with long low head; black, straight hair, and round, flaring ears. The present European prototype is the Iberian, or Mediterranean race of Sergi. The union of these traits with the Negrito resulted in a small, dolichocephalic, broad-nosed type. The mingling of types M and A with the Negrito and their recent contact with the Negritos of the Philippines produced the Igorot (M, A, N). The process of amalgamation has been a long one, and it is not yet complete. The European migration eastward was in early prehistoric times, probably Paleolithic, when the types of white men were more distinct than at present, yet fewer in number and not so differentiated. Any hypothesis to explain the amalgamation of three different types, and the production of the Igorot by this amalgamation, presupposes at least three things: The segregation of unit characters in allelomorphic pairs, the dominance of one unit character in each pair, and the apparent disappearance of the other unit character. For instance the head of the Iberian is dolichocephalic, that of the Negrito is brachycephalic. The head of type A is dolichocephalic.

and in order to account for this it is necessary to consider the broad head and the long head as unit characters of an allelomorphic pair, with the long head dominant. So the nose of the Iberian is leptorhine, that of the Negrito platyrhine; and the nose of type A is platyrhine, therefore, the wide nose is dominant. Many factors, such as environment, natural and sexual selection, the relative number of each type which enter into the amalgamated product, the time during which amalgamation has progressed, etc., exert an influence that must be reckoned with[58].

The broad nose of the aboriginal persists by sexual selection. The long head of the Iberian with greater mental capacity than the Negrito persists by natural selection. In order to illustrate the amalgamated condition of the Igorots at present I have prepared a simple diagram (fig. 13) to supplement my theory of heredity[5].

VIII. A SUPPLEMENTARY THEORY OF HEREDITY

When dominant and recessive meet in equal numbers the proportion in the second generation is 3 dominant to 1 recessive, and this proportion remains the same in future generations



Hardy[16] has demonstrated by simple mathematics, that a dominant character such as brachydactyly would not tend to increase in a mixed population after the second generation, in the absence of counteracting factors. Were Mendel's laws continuous in their operation throughout the life history of an endogamous people who represent two elementary species crossed, then one would expect the two to remain distinct and in definite proportions. But suppose Mendel's laws act for only a limited time, after which blending begins, then in the course of time the two elementary species would disappear by becoming absorbed in the blend, and a variable blend would result, the individuals representing every grade of difference between the original types. The blend may even become so perfect as to form a new elementary species if time is long enough and inbreeding sufficiently strong. The new species may be unlike either of the original and not a perfect blend of the two because of dominant factors and through extraneous influences.

The accompanying diagram illustrates my ideas in several ways. (Fig. 13.)

Point 1 is where the two types meet. Between this and point 2 there is true Mendelian heredity. At point 2 blending begins, and continues afterwards. From point 1 to point 3, spurious Mendelian heredity exists, because the blend continually crosses with the other types and creates endless confusion. Between points 3 and 4, no Mendelian heredity is found, but two tendencies exist, the persistence of type and the tendency to fuse. The diagram shows at a glance the relative number of each type at any given time.

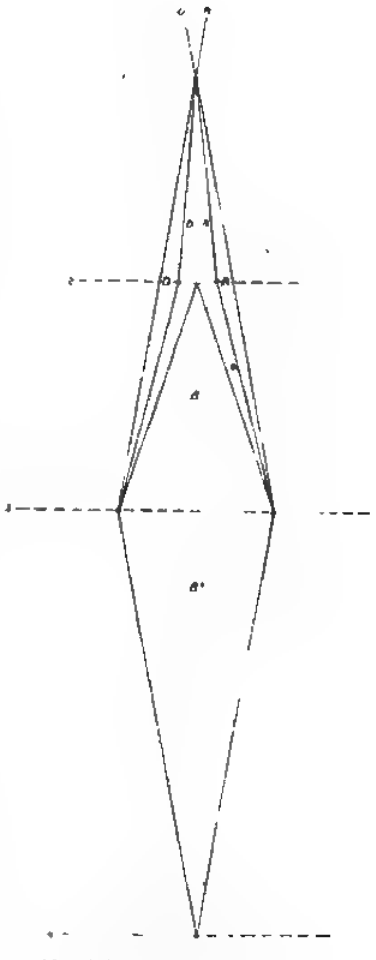


FIG. 13.—Scheme to supplement my theory of heredity.

In order to apply this scheme to the Igorot it is necessary to consider that three elementary species have united. First the Iberian and the Negrito blended and were in the condition of no Mendelism represented by type A or by the Senoi; then they were joined by type M, which was also in the condition of no Mendelism, resulting from the fusion of the Bavarian and the Negrito. The fusion of types M and A was in progress when the Negrito was again encountered since the arrival of the Igorots in the Philippines. The mingling of the types was probably more frequent than I have represented it, the crossings and recrossings more complex, and out of the moil of men through ages is evolved the Igorot.

A definition of elementary species which is of interest in this connection has recently been given by Spillman(55). This author illustrates clearly by a field of corn that each elementary species is "merely a cross section of a real variable species, and that the major part of variation is accounted for simply as a result of the recombination in each generation of Mendelian characters, each of which may vary between wide extremes, just as a species varies under the Darwinian theory of evolution. Under this view, a so-called elementary species is simply a completely homozygous form, which necessarily reproduces itself with absolute fidelity (my perfect blend).[3] The results secured by a breeder of so-called elementary species are a necessary result of Mendelian behavior of Darwinian characters."

[3] Inserted by the author.

The measurements of a few individual Igorots are given to illustrate the combination of different characters in single individuals.

Name	Height	Cephalic index	Nasal index	Facial index	Ear index	Skin	Nose	Age
Uabang	142	76	95	80	58	Brown	Australoid	53
Oci	146	89	83	73	57	Light brown	Aquiline	18
Obal	150	86	93	76	51	Brown	Australoid	65
Anoka	156	73	72	71	49	do	do	37
Mora	158	78	95	80	53	do	Aquiline	35
Peso	158	86	95	73	48	Dark brown	Australoid	25
Na Ñgis	168	74	93	78	50	Brown	do	30
Palasi	168	72	95	84	48	do	Aquiline	47
Canutu	170	80	82	81	54	Light brown	do	24

Three small Igorots, three tall Igorots and three medium-sized Igorots are selected. One of the small men is dolichocephalic, one is mesocephalic and one is brachycephalic; the same is true of the medium sized, but two of the tall are dolichocephalic and one is mesocephalic. One individual in each trio has a narrow nose, whereas two in each have very wide noses, and a similar condition is true of the face and of the ear. One tall and one small individual have light brown skins, and one aquiline nose is present in each group. The Igorots are not yet completely fused in all characters, although the fusion is more marked in some characters than in others. Uabang represents type A, Obal the Negrito, while Oci is neither. Palasi represents type M, to which Na Ñgis approaches closely, but from which Canutu diverges, although the tallest of the three; Anoka, Mora and Peso represent blended types.

Finally, the exact measurements of two Igorots and an American are placed together for comparison.

Comparative measurements of 2 Igorots and a Caucasian man (the first two were measured at the same time and place).

Measurement of—	Igorot (Martin).	Caucasian.	Igorot (Mora).
	cm.	cm.	cm.
Height	162.8	172.0	167.7
Shoulder	126.6	142.0	129.8
Umbilicus	90.0	104.0	92.5
Pubis	75.1	82.0	78.4
Knee	40.8	47.0	42.4
Upper arm	30.4	31.0	31.1
Forearm	21.9	22.5	22.3
Hand	17.8	19.5	16.1
Head length	19.6	19.7	19.2
Head width	11.8	14.6	14.8
Head height	13.2	13.0	13.4
Forehead width (narrowest part)	10.1	10.4	10.4
Bizygomatic	13.6	13.7	14.2
Chin-nasion	11.1	11.3	11.4
Width of nose	3.5	3.4	4.0
Length of nose	4.4	4.6	4.2
Between eyes	3.3	3.4	3.5
Age	45	40	35?

The simplest explanation of all the phenomenal variations heretofore presented seems to be that the Igorot has been isolated long enough to reach the amalgamated stage of no Mendelism.

The unit characters in all individuals have not blended, but occasionally manifest the character of the original type in a diversified way as represented by the nine Igorots, and not infrequently an individual of almost pure type appears, who is a true European (Martin). These are but relics of a departed Mendelism.

Efforts to reconcile Mendel's laws with the prevailing views of blended effects in heredity need not be unavailing, if the two may be considered as phases of the same process acting at different times during the life history of an elementary species.

Heredity represents all the changes of organic life by three factors(5):

1. *Determinants*, which are in the germ plasm;
2. *Modifiers*, which are all influences through time and space that act on the germ plasm; and
3. *Laws of change*, which are the rules of conduct by which the determinants and the modifiers interact.

These factors are variable when looked at through all space and during all time, but for any elementary species in a given space and for a limited time they are fixed.

D and R (fig. 13) represent homozygotes of an allelomorphic pair that meet at 1 in sexual union, begin to blend at 2, present the picture of a variable blend at 3, and fuse completely into a perfect blend at 4. A cross section of the diagram above line 3 represents the relative number of individuals of the different kinds present at that time. The width of the diagram also indicates the amount of variation at any time. D=homozygous dominants; R=homozygous recessives; DR=heterozygotes; B'=a variable blend ever increasing in number with each successive generation; while D, R, and DR decrease to disappear entirely at 3. B^2 represents the continuation of the blend without either of the originals of the allelomorphic pair, but with all shades of intervening characters blending in various ways as influenced by ancestry and by environment, until a homozygote is formed at 4.

From 1 to 2 true Mendelism exists, spurious Mendelism is found from 2 to 3, and from 3 to 4 no Mendelism is present but two tendencies prevail, (*a*) the reversion to type, and (*b*) the tendency to blend.

The three Mendelian (?) conditions may exist at the same time in a single individual, one character exhibiting true Mendelism, another false and a third no Mendelism, or only one condition may be present at one time.

Davenport and Davenport(13) have established true Mendelian heredity for eye color in man; Bateson(2) has designated many conditions in man which indicate spurious Mendelism; and Boas(7, 8, 9, 10) has suggested the two hereditary tendencies above mentioned (*a* and *b*) when broad headed and long headed or wide faced and long faced individuals are united in marriage.

My records of negroes(3), of white students(4), and of the Filipinos suggest that composite types (elementary species?) of men when crossed with opposite types follow the laws of Mendel for not many generations, then begin to blend, and eventually fulfill the requirements of my scheme delineated above. At present all mixed races are probably in a condition of spurious Mendelism or no Mendelism. Among the negroes in America the Hottentot is rarely seen, the Kaffir is often encountered, and the Guinea Coast negro is abundant, but the majority of the negro population represents a variable blend of different negro types, and a large number of mixed bloods. Among 1,000 students at Ann Arbor I observed a few of each of the types of Europe, such as the Iberian, Northern, Alpine, Celt, Littoral, and Adriatic, but the majority of the students were variable blends, and the pure types were not exactly like the prehistoric types of Europe from which they were probably derived, although similar to them in many ways. During the past year my anthropometric investigations have included the Filipinos of many provinces, but especially the Igorots. Here as elsewhere pure types are rare and blends are plentiful. Three primary types are found among the Igorots. However, none of these are pure, but one type resembles the Negrito, another, one of the prehistoric types of Europe, while the third is unlike either of the others, but not a blend of the two. The majority of the Igorots represent a variable blend, and they have been so long isolated that a condition of no Mendelism has been reached. There is conclusive evidence of the persistence of type, yet the tendency to blend is emphatic.

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ILLUSTRATIONS.

PLATE II.

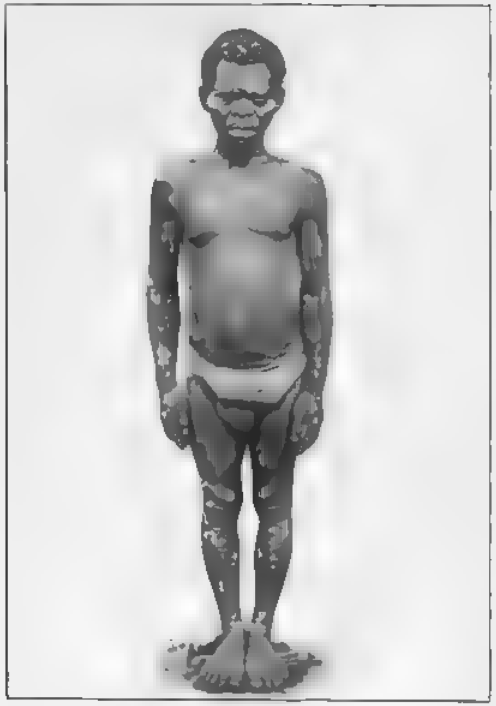
PLATE III.

PLATE IV.

PLATE V.

PLATE VI.

PLATE VII.



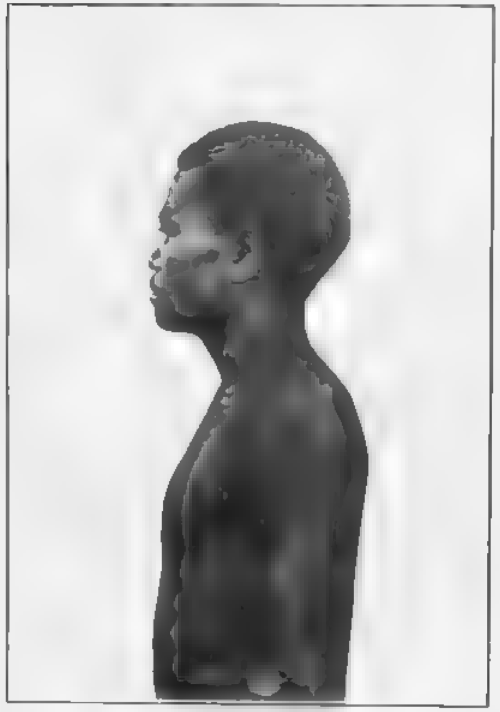


PLATE VIII.

TABLE I.—*Nativity.*

Average age.	Nativity.		♂	♀	Total.
20	Lepanto Bontoc: Remote and inaccessible		15		15
38	Highlands: Mountains and inaccessible	Atoc (2,000 m.)	42	10	73
		Tublay	21		
		Capangan			
22	Lowland:				
	(*a*) Valleys and open country	Kabayan	9		30
		Baguio	8		
		Trinidad	6		
		Bugnias	5		
		Daklan	2		
	(*b*) Baguio and vicinity	Hulalacao	4		27
		Lukbar	2		
		Cayapa	1		
		Balili	1		
		Loo	1		
		Others	18		
26	Total				144

TABLE II.—*Stature, in centimeters (adults).*

	Number.	140.	142.	144.	146.	148.	150.	152.	154.	156.	158.	160.	162.	164.	166.	168.	170.
Bontoc Igorots	14					1			2	2	2	1	1	3	2		
Atoc	30		1	1	1	2	3	7	1	1	3	3	2	2		1	1
Tublay-Capangan	16						3		5	4	1	1		1		1	
Total, mountain and inaccessible	46		1	1	1	2	6	7	6	6	4	4	2	3		2	1
Kabayan	5					2		2		1							
Bugnias	5					1	1		1				2				
Trinidad	5			1			1	1		1	1						
Baguio	5						1		1		1	1	1				
Daklan	2					1				1							
Total, river valleys	22			1		4	3	3	2	3	2	1	3				
Baguio and vicinity	22		3		4		5	3	3	2		1	1				
Total, adult Igorots	104		4	2	5	7	14	13	11	13	8	7	7	6	2	2	1
Females	10	135	1		4		1		3								

TABLE III.—*Stature, in centimeters (adults).*

Nativity.	Number.	Mean.	Minimum.	Maximum.	Mode.	Median.
Lepanto-Bontoc	14	158.6	148.0	166.0	161.0	159.0
Highland	46	154.9	142.0	170.0	152.0	154.0
Valley	22	158.6	144.0	162.0	148.0	152.0
Baguio and vicinity	29	149.1	142.0	162.0	160.0	150.0
Total	104	154.0	142.0	170.0	160.0	154.0
Adult negroes of American	136	.....	151.0	195.0	165.0	168.0
Higland women	10	146.7	135.0	154.0	146.0	146.0
Bontoc (Jenks)	32	160.3	144.0	183.0	.....	.....

TABLE IV.—*Comparison of stature with age (males).*

IGOROTS.

Age.	Number.	Mean.	Minimum.	Maximum	Mode.	Median.
5	2	97.0	92	102	.....	.....
6 to 9	2	121.0	114	128	.....	.....
10 to 11	7	122.5	111	126	.....	124
12 to 13	6	133.3	130	138	.....	134
14 to 15	18	141.9	134	158	141	142
16 to 17	8	152.7	148	162	152	152
18 to 19	19	150.0	142	162	146	148
20 to 29	43	156.0	148	170	156	156
30 to 39	18	155.3	142	162	154	154
40 to 49	10	155.0	144	168	154	154
50 to 59	3	161.0	156	168	.....	160
60	1	160.0	160	160	160	160
65	1	150.0	150	150	150	150

AMERICANS.*

Age.	Number.	Height.	Age.	Number.	Height.
5	203	105.78	13	515	145.09
6	410	110.67	14	435	151.02
7	344	115.69	15	327	158.18
8	563	121.31	16	218	163.73
9	546	125.86	17	512	169.98
10	496	130.96	18	723	171.07
11	600	134.90	19	796	171.81
12	559	140.29	20	736	172.22

* Hastings, 8,245 individuals.

TABLE IV.—*Comparison of stature with age. (males)*—Continued.

EUROPEANS[a]

Age	Height.	Age.	Height.	Age.	Height.
5	105.6	11	135.4	17	167.8
6	111.1	12	140.0	18	169.0
7	116.2	13	145.8	19	170.8
8	121.3	14	152.1	20 to 29	172.5
9	126.2	15	158.2	30 to 34	172.8
10	131.3	16	165.1	34+	172.5

[a] Topinard, 1,101,841 individuals.

TABLE V.—*Absolute length of upper arm (brachium).*

Group.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	Total.
Bontoc													1	1	2	2	5	2	1								14
Mountains													3	10	8	13	4	4	2	1							45
Lowlands											1	8	9	8	7	6	2	3									44
Adult males											1	8	13	19	16	22	12	8	3	1						1	103
Women										1	2	3	1	0	1	2											10
Boys, 12 to 15									1	1		4	4	6	1	2											19
Boys, 10 to 12								1	1	2	1	1															7
Boys, 10 and less	1		1	1			1																				5

TABLE VI.—*Absolute length of forearm (antebrachium).*

Group.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	Total.
Bontoc								1		1	2	1	2	2		1					13
Mountain								1	5	13	13	7	2	2	3						46
Lowlands							2	2	8	7	7	7	5	2	1	1					42
Adult male							2	4	13	21	22	18	9	6	1	2					101
Women						1	1	1	2	3	1	1									10
Boys, 12 to 15						4		1	5	4	2	1	1		1						19
Boys, 10 to 12				1	2	2															5
Boys, 10 and less	1	1			1	2															5

TABLE VII.—*Absolute length of hand (manus).*

Group.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	Total.
Bontoc						1	2	2	3	1	1	13
Mountain			1	1	7	8	14	10	3	1		45
Lowland			1		6	10	11	6	4	4	1	43
Adult male			2	1	13	19	27	15	10	9	2	101
Women		1			2	1	3		2	1		10
Boys, 12 to 15		2	3	2	3	3	5	1				19
Boys, 10 to 12	1	1		1	2	2						7
Boys, 10 and less	1		3		1							5

TABLE VIII.—*Standard according to the canon of Fritsch.*

No.	Type.	Locality or race.	Author.	Modulus.	Upper head height	Extremity; length.	
						Upper	Lower
1	Protomorph	South American man	Stratz	6.50			
2	Melanoderm	Negro man	do	7.25			
3	Xanthoderm	Chinese man	do	7.50			
4	Leukoderm	German man	do	7.90			
5	Protomorph	Karaya maiden	do	6.66			
6	Melanoderm	Dschagga maiden	do	6.80			
7	Xanthoderm	Japanese woman	do	6.30			
8	Leukoderm	Rhineland woman	do	8.00			
9	Protomorph	Australian woman	do	7.11			
10	do	do	Ranke	6.75			
11	do	Papuan man	Stratz	6.70			
12	do	Bushman	Denikar	7.10	(a)	(a)	(a)
13	do	Hottentot woman	Bonaparte	7.45			
60	Metamorph	Igorot man	Bean	7.60			
3	Protomorph	do	do	7.40			
88	Metamorph	do	do	7.90			

a Not given.

TABLE IX.—*The selected types; averages, and indices or relative factors.*

ABSOLUTE—AVERAGES.

Type	Number.	Stature.	Width shoulders.	Head length.	Head height.	Forehead width.	Between eyes.	Eye width
M	8	164.5	36.1	19.4	13.3	10.5	3.6	2.8
A	9	146.6	33.5	18.8	12.6	10.2	3.3	2.7
N	8	150.3	33.1	17.7	12.8	10.2	3.1	2.9
Senoi I	17	149.5		17.9	13.2	10.2	3.4	
Average Igorot	101	154.0	34.8	18.8	12.9	10.3	3.85	2.85

RELATIVE—INDICES

Type.	Arm.	Leg.	Forearm.	Hand	Brachial index.	Shoulder.	Cephalic index.	Nose index	Ear index.	Artistic canon.	Lower face to total head.	Omphalic index.
M	44.3	51.9	14.4	10.8	74.6	22.0	71.4	96.0	52.8	7.4	29.4	43.4
A	43.6	51.2	14.2	10.8	75.1	22.9	73.1	97.7	55.8	7.0	29.8	39.0
N	44.9	51.2	14.8	10.7	80.0	22.0	84.3	89.4	55.6	7.2	32.6	40.9
Senoi I	43.9	52.1	14.0	11.2	76.0		80.0	85.8		8.00	30.0	
Average Igorot	44.0	51.6	14.4	10.5	76.2	22.6	78.0	92.7		7.1	31.0	41.1

A GEOLOGIC RECONNAISSANCE OF THE ISLAND OF MINDANAO AND THE SULU ARCHIPELAGO. I.—NARRATIVE OF THE EXPEDITION.

By WARREN D. SMITH.
(From the Division of Mines, Bureau of Science.)

CONTENTS.

I. INTRODUCTION.

The Mining Bureau of the Philippine Islands, and subsequently the division of mines of the Bureau of Science, has now been in existence approximately ten years and during this time its scientific employees have visited nearly every part of Luzon and the Visayas, but up to the present the large southern island of Mindanao has been neglected. The reason for this is twofold; work was necessary in other and more important fields and only recently have conditions been such that travel in the greater part of Mindanao has been possible without a regiment of soldiers, although even now it is necessary in many places to take a detachment of from three to twenty men, as the Moros are still disturbing the peace in certain quarters.

One or two localities on the coast were visited by members of the *Cuerpo de Ingenieros de Minas* during the Spanish régime and I shall allude more fully to their work in the following pages.

The existing dearth of information in regard to this island led me, as chief of the division of mines of the Bureau of Science, to undertake a general reconnaissance of Mindanao and the Sulu group. Such a general view is necessary for planning future systematic and more detailed study.

The following four objects were in mind in beginning this expedition: (1) The rapid reconnaissance of the geology; (2) the examination of

certain special areas likely to prove of economic interest; (3) topographic route sketching, and (4) securing a knowledge of the work of the prospectors in the field.

The party consisted of Warren D. Smith, geologist in charge; Maurice Goodman, mining engineer; Harry M. Ickis, topographer; Robert N. Clark, assistant; as well as Lieutenant Charles S. Caffery, United States Army, in charge of the military escort. The journey was only made possible by the assistance of the latter and our thanks are due to General Tasker H. Bliss, governor of the Moro Province, and to Lieutenant Caffery for their cordial assistance.

The map at the beginning of this paper shows the position of Mindanao and the Sulu group with relation to the remainder of the Archipelago. Roughly, these islands lie between the parallels 5° and 10° north latitude and between 119° and 127° east longitude. The route of the party is indicated by the heavy line.

The work was divided as follows: That on the Zamboanga Peninsula and the Sulu group was done by W. D. Smith accompanied by Lieutenant Charles S Caffery; the vicinity of Cagayan and Iligan, Misamis Province, was investigated by H. M. Ickis, assisted by R. N. Clark; W. D. Smith and H. M. Ickis, accompanied by Lieutenant Caffery and an escort, surveyed from Camp Overton through the Lanao Lake country to Cotabato and from Cotabato to Davao; the ascent of Mount Apo was made by W. D. Smith, Maurice Goodman, and H. M. Ickis; Maurice Goodman and H. M. Ickis went from Davao up the Tagum and Saluug Rivers to the headwaters of the Agusan and thence to Talacogon. Maurice Goodman then proceeded to Surigno and Placer, while H. M. Ickis made a reconnaissance to San José de Bislig and back to Talacogon.

II. PREVIOUS WORK OF A GEOGRAPHICAL OR GEOLOGIC NATURE IN MINDANAO.

No attempt will be made to review the work of all the men who have undertaken expeditions through the southern islands of the Philippine Archipelago. I shall confine my attention to those who have contributed in a marked degree to our knowledge of their geology and geography.

The first map of Mindanao which is at all accurate was made by the Jesuit Fathers. Of course, this map is based on little or no triangulation, but when the size, nature of the country, and state of the natives are considered the work reflects great credit upon those who did it.

Since the American occupation the United States Army has done practically all the mapping which has been accomplished in Mindanao. The work of this organization has been excellent. Besides making route maps of all the country traversed in the course of its expeditions, it has begun a progressive military map which shows the topography by contours, based on triangulation. This will, when completed, be by far the most accurate work done over so large an area by any organization in these Islands.

The United States Coast and Geodetic Survey is now engaged in surveying the coasts of the southern islands.

Much less has been accomplished in relation to the geology, but there is ample excuse for this lack of results. To use the expression of Dr. G. F. Becker, "such work in a country where the natives are not on the best of terms with you is more exciting than profitable."

Among our Spanish predecessors, Sainz de Baranda, Centeno, Montano, Espiña, and Abella have contributed to our knowledge of the geology of Mindanao. The work of the latter was confined almost entirely to the Misamis region, but it is the best of all the contributions from that part of the island.

The following appear among other Europeans who collected in Mindanao or studied its geology: Semper, Richthofen, Minard, and Renard. K. Martin worked on some fossils which came from Mindanao and Oebbeke described certain rocks collected on that island. Martin and Oebbeke have never been in the region.

Dana, Ashburner, and Nichols were Americans who visited Mindanao before the American occupation and who contributed to a knowledge of its geology and finally, Dr. Becker was in the Archipelago in 1898, just at the outbreak of hostilities with the natives.

Guillemard and Becker seem to have been the only investigators who touched at any part of the Sulu group. The former barely mentions Cagayan de Sulu, and the latter could only study the islands from the deck of the vessel, as the natives were at that time in a very warlike humor.

Dr. Becker[1] in his report gives a brief summary of the previous work in Mindanao and the following is a quotation:

"Concerning the great Island of Mindanao, only scattered observations are available. Sainz de Baranda[2] noted the occurrence of serpentine on the east coast of the island at Canmahat and in Misamis Province at Pigtao. Mr. Centeno states that at Pigholugau, near Cagayan, in the Province of Misamis, there are quartz veins in talcose schists. The auriferous districts of the Province of Surigao may, he points out, be regarded as a continuation of the Misamis district. The most notable deposits here are in the mountains of Canimon, Binuton, and Canmahat, a day's journey southward from the town of Surigao. The terrane is here composed of much altered talcose slate and serpentine.[3] Mr. Semper collected on the Maputi, which is an upper tributary of the Agusan River in Surigao. Here he found a uralitic gabbro and a chloritized, aphanitic, augite-plagioclase rock, containing a few plagioclase phenocrysts. The specimens have been described by Mr. Oebbeke.[4] They are probably facies of the melaphyres found by Mr. Montano. Mr. Ashburner examined a slate belt in the extreme northern portion of the island, about 8 miles to the southward of the town of Surigao, at the headwaters of the Cansuran River. It contains auriferous quartz stringers. Mr. Montano collected melaphyres at a number of points in eastern Mindanao. Such are the eastern shore of the Bay of Butuan, the eastern coast of the island between Bislig and Catel, and the divide between the waters which flow northward into Butuan Bay and those which flow southward into the Gulf of Davao. The river of this southern drainage basin Montano terms the Salug. Other authorities give it different names. In its headwaters he found float consisting of melaphyre

[1] Report on the Geology of the Philippine Islands, *U. S. G. S. 21st An. Rep.* (1899–1900), Pt. 3, 507.

[2] He also mentions crystals of rutile from an island called Bigat, which is unknown to me. *Anal. d. Min.*, Madrid (1841), 2, 197–212.

[3] Memoria geológico-minera (1876), 49.

[4] *Neues Jahrb. f. Mineral.*, etc. (1881), Beil.-Band 1, 498.

and quartz porphyries. Melaphyre he found again at Pujada Bay near Cape San Agustin. Quartz breccias also occur on the divide between Pujada and the Gulf of Davao. Serpentine accompanies the melaphyre to the south of Bislig.[5]

"Mr. Minard visited the gold-bearing region of Misamis, the northwestern province of Mindanao. The sandstones and conglomerates of the Iponan Valley, dipping 12°, are said to be broken through at many points by diorite and serpentine. The pebbles of the conglomerates include diorites, augite-porphyry, serpentine, jasper, and marble.[6] Some years later Mr. Abella made a reconnaissance of this region, examining the gold deposits along the courses of several rivers, all of which empty into Macajalar Bay. They are the Iponan, the Cagayan, the Bigaan, and the Cutman. In this region he found two considerable areas of old slates. One of these touches the Iponan River 10 or 12 miles from the sea. The other is intersected by the Cutman and approaches the sea within 2 miles, near the town of Agusan, which lies at the mouth of the Cutman River. Alluvial deposits fringe the shore of the bay and follow the streams. Otherwise the country, as depicted by Mr. Abella, is covered with strata provisionally referred to the Miocene. The slates are described as metamorphic and in part steatitic. The pebbles of the Tertiary conglomerates consist of such slates, serpentinoid rocks, and many varieties of 'trachytic rocks.' I think that at the date of his memoir, 1879, Mr. Abella used this term for neo-volcanic rocks not basaltic in appearance. The description of the fossiliferous rocks overlying the slate leaves no doubt but that they are Tertiary or Recent, a fact which it is difficult to reconcile with Mr. Minard's statement that they are cut by serpentine and diorite. In the placer at the Bigtog, tributary to the Cagayan, Mr. Abella found slightly rounded, large pebbles of orthoclase.[7]

"A few miles northwest of Zamboanga (in southwestern Mindanao), at Caldera, Dana observed hornblendic and talcose schist in pebbles,[8] and on Malanipa, about 13 miles E. by S. from Zamboanga, the *Challenger* expedition collected serpentinized peridotite, studied by Mr. Renard."[9]

III. GENERAL GEOGRAPHIC DESCRIPTION AND ITINERARY

The main body of the Philippine Archipelago is connected with Borneo by two parallel chains of islands, one consists of Busuanga, Linapacan, Palawan and Balabac, while the other extends southwest from the Zamboanga Peninsula, comprising Basilan, Sulu, Siasi, and Tawi-Tawi. The inference is that there has been entire land connection at some time in the past. This question will be referred to in a future chapter, at this place it is sufficient to state that there are some objections of a very reasonable nature to such a conclusion.

The Sulu Group and Mindanao together possess a rough likeness to a long-handled dipper, the Sulu Islands and Zamboanga Peninsula constituting the handle, the eastern part of Mindanao the bowl. Mindanao is marked by its great number of bays and gulfs, its two great rivers,

[5] Mission aux îles Phil. (1879–1881), 272–277.
[6] *Bull. Soc. géol.* France (1874), V, 2, 403–406.
[7] Mem. acerca de los criaderos auriferos . . . Misamis (1879), 4, 18, 32, 45.
[8] *U. S. Expl. Exp.* (1840), 10, 539.
[9] *Ibid*

its nine or ten lakes and its high mountains. One of the latter, Mount Apo, 2,928 meters, is supposed to be the highest peak in the Archipelago.

A glance at the map of Mindanao prepared by the Jesuits will reveal the presence of four main tectonic lines, three of which run approximately north and south, and the fourth east and west. The first is the line following the crest of the range which extends parallel to the long axis of the Zamboanga Peninsula; its direction is N. 20° E. The second seems most nearly to mark the eastward trend of this range; its direction is approximately N. 85° W. Along this line are to be found Mount Sugarloaf, just north of Dumankilis Bay, Mount Dapan, a short distance southwest of Lake Lanao, Mounts Kalatungan and Latukan east of the lake, and Mount Agtunganon east of the Agusan River.

The next line is that which follows the Apo Range. This is very pronounced from Apo southward, but is not especially marked to the north. On this line are to be found Mount Apo, 2,928 meters, and Mount Matutum, which is doubtless somewhat lower.

The fourth, which is not as straight as the others, extends along the backbone of the country east of the Agusan River; its general direction is about N. 8° W. No very important peaks exist along its extent.

The first of these four lines, which follows the backbone of the Zamboanga Peninsula, is the most marked in that it extends northward through the Island of Negros, coinciding exactly with the tectonic line of that island and cuts across the lower part of the prong of Masbate, again coinciding with the long axis of Sorsogon and the Catanduanes. The Agusan line, by curving a little to the west, would fit closely with the tectonic lines of Leyte, Masbate, and Tayabas. There is no question but that there is a definite and fairly uniform system of folding and fracturing throughout the Archipelago, the various islands representing the irregular crests of the anticlines while the intervening straits mark the synclines.

There are no very large rivers in the western part of Mindanao, although a fair-sized river follows along the central line of the Zamboanga Peninsula, and two short, swift streams also exist, one of them the Agus, draining Lake Lanao and emptying into Iligan Bay after a run of about 30 kilometers, and the other, the Mataling River, drawing part of its water from Dapan Lake and part from the northern slopes of the Kulingtan Range. A different condition exists in other parts of Mindanao.

The *Rio Grande de Mindanao*, over 300 kilometers long, is the second largest river in the Philippine Archipelago. Its course is from north to south until within a short distance of Lake Liguasan where it turns sharply to the west, emptying into Illana Bay. This river is navigable

for shallow-bottomed, stern-wheel steamers for a distance of over 200 kilometers. The valley of the Rio Grande presents a wonderful stretch of country.

The Agusan River, next in size, flows from south to north in a fairly uniform direction. It is probably at least 250 kilometers in length.

Mindanao in general is rather densely covered with jungle containing much fine forest. No large industries, unless it be agriculture, exist in the island, if one sawmill, erected by Americans not far from the town of Zamboanga is excepted. There are neither mines nor factories, the little that has been accomplished has, for the greater part been the result of the energy of a few Americans and Spaniards. For the most part this great and enormously fertile island is a silent, almost trackless jungle.

We can only conjecture what the mineral wealth of Mindanao really is, for few as yet have had the hardihood to attempt prospecting in this region.

IV. PEOPLE.

The distribution of the different tribes can be learned by reference to the map prepared by Dr. N. M. Saleeby[10] to accompany his researches into the life of these people. It is not my intention to discuss very fully the racial characteristics of the people inhabiting Mindanao, as Dr. Saleeby will do this fully and thoroughly. However, it will be necessary to make brief mention of the character of the inhabitants in this paper and to make this portion as accurate as possible I have not only drawn from personal observations, but more frequently from Dr. Saleeby's first work.[11] Other sources of information have also been used.

A line extending roughly from Iligan in a southeasterly direction to the Kidapwan Mountains and thence south to Sarangani Bay will divide the island into two great ethnological divisions. To the west of this line the Moros, a Mohammedan people, are dominant. To the east are various tribes which in all probability spring from Malay stock and who presumably came to Mindanao long before the Mohammedan invasion. The Sulu group to the south of Mindanao is inhabited almost entirely by Moros.

A considerable number of Visayans and a few Tagalogs, who have emigrated from the northern islands, are encountered along the coasts and at the mouths of some of the rivers.

[10] Saleeby, N. M.: The History of Sulu, *Pub. Div. Eth., Bureau of Science*. Manila (1908), 5, 11. The map of Mindanao will be published in Dr. Saleeby's work "The History of Magindanao" now in course of preparation.

[11] Saleeby, N. M.: Studies in Moro History, Law, and Religion, *Pub. Eth. Sur.*, Manila (1905), 4, 1.

V. CLIMATE.

It is difficult to discuss the meteorologic conditions of Mindanao in a general way. The fairly regular and distinctly marked seasons which prevail in Luzon do not seem to obtain in Mindanao. The following table is taken from the monthly reports of the Philippine Weather Bureau:

Rainfall, in millimeters, at Mindanao and Sulu stations during 1905.

Month	Zamboanga.	Isabela.	Jolo.	Davao.	Surigao.
January	8.7	13.2	38.1	79.0	105.3
February	2.6	1.5	0.0	121.4	101.1
March	0.0	0.0	22.4	206.2	81.9
April	37.3	9.6	0.0	88.4	130.6
May	143.5	102.4	305.0	417.8	176.9
June	25.3	54.0	19.6	192.3	0.0
July	214.6	140.2	209.9	341.4	167.3
August	84.1	112.4	38.9	328.3	112.0
September	63.6	145.3	229.6	160.0	216.8
October	148.2	320.9	420.4	127.3	112.8
November	107.7	112.3	59.4	66.5	380.4
December	57.7	91.2	69.6		483.6
Total	892.3	1,103.0	1,412.9	2,120.7	2,068.7

A great difference is shown between the rainfall at Zamboanga, at Surigao and at Davao, and the results are very evident in the difference between the forests of these portions of the island. Zamboanga Peninsula is fairly well forested, if the plain which has been cultivated for a long time is excepted, but the forest of this region is not by any means as luxuriant as that of the Agusan and Davao Valleys. The densest forests in the Philippine Islands, with the possible exception of portions of Mindoro, are probably to be found in the latter districts.

I was not in the country for a sufficient length of time to render any statement I might make in regard to the healthfulness of various parts of Mindanao of value. The low country in the river valleys and the lake region to the south of the Cotabato is probably not as healthful as the highlands of the Lanao region. Mosquitoes abound in many parts of the former territory and great precautions must be taken against them. The Cotabato River has a particularly bad, but I think undeserved, reputation in this respect. I had no fever nor any sickness whatever during the five months I was in Mindanao, but both native and American troops have suffered considerably from malaria.

A table of the temperatures for the various stations of the island follows:

Table showing mean maximum and mean minimum temperatures, in degrees centigrade, for Mindanao stations during 1907.

Month	Surigao.		Jolo.		Isabela.		Zamboanga		Davao.		Cotabato.		Dapitan		Butuan.		Carago	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum	Minimum	Maximum.	Minimum	Maximum.	Minimum.	Maximum.	Minimum.	Maximum	Minimum.	Maximum.	Minimum	Maximum.	Minimum
January	29 0	21.8			30.9	21 5	30.3	21.8	32 2	22.7				23.1	28.4	21.3	30.6	21 8
February		22.4			31.3	21.9	30.3	22.3	31.7	22.3				22 6	28.6	21.7	29.5	21 9
March	29.6	21.6			31.6	22.2	30.9	22.8		22 6				23 6	29.4	21.9	29.7	21 7
April					31.4	22 0	30.6	23 0	32 7	23.0				23.6	31.0	22 2	30.5	22 0
May					31 0	22 3	30.6	23 3	33.0	23.0				23.6	33.0	23.3		
June	32 4	22.9			31.2	22 5	30.1	23.3	32 3	23.2				22.9	32.8	22.7	30.2	22.6
July	33.0	23.2			31.0	22.1	29.7	22.9	31.6	22.3	33.0	22 6		22.4		22 1	31 1	22.3
August					30.6	21.9	29.2	22 7	31.4	22.3	32 0	22.0		23 2		23 0	30.8	22 6
September			32.4	23.5	30 4	21.9	29.6	23 1	33.3	22.4	32.6	21.7		23 8	31 3	29 9		
October			31 8	22.3	30.2	22 4	30.3	22 9	33.0	22 1	33.6	22.2		24 1	30.3	22 3		
November			31.2	22.9	30.3	22.6	30.3	23.0	32.5	23.3	33.6	22.0		23.7	28.9	21.8		
December	28.3	22.1	30.9	23.2	30.6	22.6	29.7	23.0	30.9	22.3	33.2	22.1		23.3	27.9	22 2		

SMITH.

The region around Camp Keithley, owing to its altitude is much cooler than the low country and the climate is correspondingly invigorating. However, at certain times of the year, particularly in December and January these posts are said to be very disagreeable, as they are cold and raw like the New England coast of the United States in the spring time.

Typhoons are said not to occur in the latitude of Mindanao and the Sulu Islands. The evident reason for this is that the cyclonic storms, which have their origin in the Pacific are formed in a latitude much north of that of Mindanao and as they pass westward they are constantly curving to the north, partly owing to the original, clockwise movement of cyclones north of the equator and partly because of their approach to the continent of Asia. According to Father Algué, Director of the Philippine Weather Bureau, a few cyclones form in the Sulu Sea, but these attain no great importance either in frequency or in intensity.

Plate XXIX of Father Algué's "Cyclones of the Far East" [12] shows the mean trajectories of cyclones which pass over or near the Archipelago. It is very interesting in that it reveals how very generally Mindanao and the Sulu group escape these destructive storms. This fact is of the first importance in view of damage which such storms might inflict on crops, particularly on hemp which grows to heights varying from 10 to 18 feet, and because of the relative immunity from danger to vessels, such as interisland trading ships Moro *vintas* and pearling boats.

VI. NARRATIVE OF THE EXPEDITION.

Zamboanga, the first point visited by me, is situated about 3 miles from the nearest foothills at the edge of a flat plain of considerable area at the foot of the long, narrow peninsula of the same name. (See map, Plate I.) To the east is a long stretch of salt-water marsh and in its rear is a scarcely less elevated tract which is taken up with paddy fields. If the Tumaga River had kept its initial direction, it would cut through the heart of the city, as it is, it curves to the east and enters the sea opposite Sakol Island. The substructure of this plain is coral, the superstructure, silt and coarse detrital material from the hills to the north.

Zamboanga is essentially a "gate city" and a study of the map will show its central, commanding position with reference to steamship routes. In fact this is the main feature controlling its location. It is not situated on a large river by which communication can be maintained with the interior and for this reason its position is not favorable as is that of Manila, which is on a plain on the coast and at the same time on the banks of a large stream which taps a great stretch of the interior. Cotabato, on the *Rio Grande de Mindanao*, is also favorably located and it will probably expand when the immense possibilities of the country to which it holds the key are understood.

[12] Algué, José: The Cyclones of the Far East, Bureau of Public Printing, Manila, 1904.

The initial reconnaissance which I undertook was to Boalon, some 10 or 12 kilometers northeast of Zamboanga. Here the transportation by wagon was left and a trail taken which led up an abrupt hill a little beyond which point we entered the forest. Between Boalon and this hill I found some float limestone with fragments of *Orbitoides*, which probably are identical with the material Richthofen[13] encountered so many years before. This is practically all he contributed to the geology of this region, but this is not suprising when the attitude of the natives at that time is considered.

We continued in the forest for about three days, obtaining absolutely no view of the country farther than 50 yards from the trail, until we reached a log cabin about 30 miles north of Zamboanga on the Tumaga River.[14]

The country rock in this region is a much decomposed schist, with a considerable thickness of stiff, yellow, clay overburden. (Plate III.) Quartz pebbles and bowlders are plentiful in the clay; the pebbles come from quartz stringers in the schist. The large bowlders clearly indicate large veins, but we were not so fortunate as to encounter any of the latter. The clay contains a small amount of gold which the prospectors had recovered by sluicing. Few people were encountered in this forest.

On our return after three days' stay we followed the river for perhaps 25 kilometers. At times we came upon low cañons (some of which we might have swum through), but usually we took the high trail which went along the steep side of the cliff, at times 30 meters above the water and rocks. The way was extremely difficult; the sharp river rocks, the sharp-edged schists and the leeches began to tell on our carriers, so that we finally took a trail which led out of the river and after a climb up the side of the gorge we regained the old path which we followed to a hemp plantation at the edge of the timber and by mid-day arrived in Zamboanga.

VICINITY OF SAN RAMON.

My next reconnaissance was in the vicinity of the San Ramon Farm, controlled by the Moro Province. This excursion was for the purpose of an examination of the mountains which rise abruptly back of the narrow coastal plain. The formation in this place is entirely volcanic, the rich, disintegrated débris spreading out upon the coastal plain and producing a very fertile soil. Some of the rock is highly pyritized and may carry more or less gold.

In the streams I saw bowlders of andesite which sometimes contained large fragments of schist, torn off and caught up in the molten rock as it

[13] Richthofen, F. von: Vorkommen der Nummulitenformation in den Philippinen, *Ztschr. d. deutsch. geol. Ges.* (1862), **14**, 357.

[14] A sketch map of the trail was made, but it shows little beyond the path.

poured out over the surface. This schist is identical with that found in the gorge of the Tumaga River.

I had observed terraces along the shore farther to the north in the neighborhood of Dapitan and therefore looked for some signs of elevation here. I did find one fairly well preserved terrace a few miles to the north of San Ramon, but the streams have cut through it in so many places that only an especially trained eye can see it. This terrace is perhaps 6 meters above the mean tide level. (Plate VII.) The mountains in the Zamboanga Peninsula were once covered with a mantle of limestone, but little of the latter remains, a few large bowlders in the streams being all that we could find.

This coastal strip on which San Ramon is located, disappears to the north at Patalun Point, but it widens regularly to the south and is everywhere taken up with coconut culture. The long stretch of sandy littoral from San Ramon to Zamboanga is especially adapted to the culture of the coconut palm.

This peninsula in regard to its population might be divided into the following zones:

1. The hill or forestal zone occupied by Subanums, a wild and primitive people.
2. The intermediate or rice zone by Filipinos, mostly Visayans
3. The coastal plain by Chinese and Americans.
4. The beach zone by the Moros (littoral zone).

COAL MINES AT SIBUGUEY

Following the reconnaissances outlined above I went to Sibuguey Bay, an all night run by Constabulary vessel to the northeast of Zamboanga. I was accompanied on this trip by Colonel W. C. Taylor, then in command of the Fifth Constabulary District. We anchored about a half mile offshore as we did not know the exact configuration of the reefs, this coast being but incompletely charted.

Our road to the coal measures at Sibuguey was first by boat up the Siay River, the banks of which for some distance from the mouth are lined with mangrove swamps, we taking a turn through an opening in the right bank and following an estuary until noon, when we landed and followed a trail over a low hill to the house of the *datu* of this region, Lukas, a Subanun. (See Plate VIII.)

We left this place early in the afternoon and after a very trying march through mud and over hills, we reached the site of the coal workings on the Sibuguey River. The old, abandoned tunnels of the coal mines are hidden by the underbrush. I could obtain but little idea of the condition of the seams, excepting that they are tilted and dip to the southeast. They can be worked with the mine mouth probably not over 100 meters from the Sibuguey River, which is large enough at this point, 21 kilometers from the mouth, to allow small launches and lighters to pass up and down to take on coal.

THE SULU ARCHIPELAGO.

The Sulu Archipelago is practically unknown from a geologic and physiographic point of view, so that the information gained in this expedition, although meager, is at least new.

Dr. Becker refers in four lines of his report to rocks on Marongas Island just across from the town of Jolo. Other than this there are no geological notes. Some eruptions of the year 1614 are described by the resident Jesuits but only in a crude way. It has been known for a long time from the reports of ship captains and travelers that the archipelago is largely volcanic.

This great group of islands extends for 335 kilometers southwest of Zamboanga. It is about 120 kilometers wide and contains hundreds of islands and rocky shoals. The most considerable of the islands are Basilan, Sulu, Siasi, and Tawi-Tawi and although Basilan is the largest, Sulu is of far greater commercial and historic interest.

The water is nowhere of great depth within the confines of this archipelago, but it is separated both from Borneo and Mindanao by deep straits. To reconstruct a large island out of this swarm of small ones which may or may not have formed a continuous bridge from Borneo to Zamboanga, and which would since have been disrupted and partly submerged, is not a great tax upon the imagination. The evidence we have points in this direction.

The Sulu group, like so many other oceanic islands, is either of volcanic or coral formation. I saw very little sedimentary material on any of the islands and where any such was exposed, it was usually at a point where erosion had removed the lava capping. I do not know of any marked volcanic activity in the Sulu Archipelago at the present time, although hot springs in old craters are reported on Cagayan Sulu. I have also been informed that there are hot springs and solfataras at Siit Lake on Sulu. This lake occupies an old crater. I have visited neither of these places.

An eruption at a point near Jolo, not named, is reported to have occurred on January 4, 1641.[15] As there is some confusion of names in this report I do not attach much importance to the account. As far as I can learn, no accurate scientific notes were taken at the time.

The only remaining reference I find regarding the geography or geology of the Sulu Archipelago is a note by Becker:[16]

"In the Jolo Archipelago, the charts indicate several well-developed atolls, such as Simonul Island (latitude 4° 52′, longitude 119° 50′), as well as several in the Tapul group (latitude 5° 30′). The charts of this region also show innumerable coral reefs, which are bare at low tide and must therefore have been uplifted."

[15] Baranera, Francisco X.: Compendio de geografía de las Islas Filipinas, Marianas, Jolo y Carolinas. 3r ed. Manila, 1892.

[16] Geology of the Philippine Islands, 562.

I myself have seen some coral islands near Sulu, in the Pangutaran group; some of these are atolls and others were formerly lagoons that have dried up because of the elevation of the whole mass.

While nearly all the elevations are extinct or dormant craters, there are no sharp, jagged profiles, but instead, most graceful curves. There are nearly fifty of these cones on the Island of Sulu, some still high and symmetrical, others irregular and worn down to mere stumps. (See Pl. IV.)

BUD DAJO.

We first visited the now historic crater of Bud Dajo,[17] the wooded cone of which rises from the plain back of Jolo. One afternoon of brisk riding on horseback is necessary to reach the point where the very steep climb begins at 300 meters' altitude; from here to the extinct crater is a further elevation of 580 meters. The climb is a short one, but it is the most strenuous I remember ever to have made.

Formerly there existed a community on this mountain having all the necessaries of life about them; a complete village with dwellings and a mosque; springs, gardens, and both shade and fruit trees, all within an extinct crater. The Moros added trenches and *cottas* to the natural walls of the village and long bamboos, in the hollows of which were concealed *lantakas* (brass cannon) were placed along them. (See Plate X.)

Bud Dajo is formed of scoriaceous basalt and lapilli, but has not been in eruption at least within the last three hundred years, or if it has, there is no record of the event. Large basaltic bowlders from this mountain are strewn over the slopes and the plain down to the very edge of the town of Jolo. An excellent view of a large part of the island can be had from the highest point on the walls of the crater. From this point smaller craters are visible and it is not impossible that renewed energy may at some future time be manifested at one or more of the many foci and a considerable destruction of lives and property be the result. The fact that these craters appear extinct is no argument against future activity.

FURTHER RECONNAISSANCE OF SULU.

On Monday, October 14, Lieutenant Caffery and I, with an escort of five men, began an expedition to Maymbung, on the opposite side of the island. The trail led past Asturias, the former residence of the Sultan of Sulu, but now the site of infantry barracks, and on over a low divide of about 300 meters' altitude, between Bud Agad and Bud Pula. The soil is of a rich red color, giving promise of unusual richness. Large fields of tapioca, which is the main agricultural product of the

[17] *Bud* is the Sulu term for mountain. As it is generally used by the military authorities, it is retained in this description.

Sulu Islands, appear on either side of the trail and Moro dwellings, with several small haystacks near by could be seen from time to time. However, large tracts of fallow land exist along the route.

The soil everywhere is the same, for a blanket of basalt apparently lies over the whole island. At Maden Patung, about a mile and a half from the Sultan's house at Maymbung, are some outcrops of tuff, the only sedimentary formation I saw while on the Island of Sulu.

We reached Maymbung late in the afternoon and the next day returned to Jolo by the same route we had come by, our stay being cut short by the consideration that a geological reconnaissance conducted under guard in a very unsettled country does not warrant the expense and the additional detail of men. "Such work is really more exciting than profitable."

Several short excursions in the vicinity of Jolo were made for the purpose of finding water-bearing strata, but in this respect the result was disappointing. However, some splendid examples of old, worn-down craters were seen. Several low, circular and apparently flat-topped hills lie at a distance of 3 to 5 kilometers southwest of Asturias. They very much resemble overturned saucers. The tops of these hills usually show a more or less marked depression, a remnant of the old crater, and two of these were inhabited by several families, with substantial houses and well-kept gardens. These people live in such situations, not so much because the soil is particularly rich, because it would be hard to find soil more fertile than that on the lower volcanic slopes, but undoubtedly because of the protection afforded by the hills, the comparative difficulty of access and the excellent lookout over all approaching trails. There is usually some water either in the central depression or at the bases of these volcanic mesas.

OTHER ISLANDS OF THE SULU GROUP

I returned to Zamboanga after this brief visit to Sulu and reshipped on a small Constabulary paymaster-boat for the more distant islands of the Sulu group. The first stopping place was at the Island of Bongao. Tawi-Tawi was not visited, such observations as were possible being made while sailing near to the coast. It is not a very rugged island, everywhere showing gentle curves.

Bongao is a small village and Constabulary station on the island of that name, separated by a narrow channel from the southwestern end of Tawi-Tawi. Coral reefs are found everywhere in these waters, so that great care in navigation is necessary. Mount Vigia, visible from the dock (see Plate XIV), is a mass of very resistant conglomerate, 370 meters high, and on a clear day the low coast of Borneo can be seen from this peak.

Some raised beaches exist in this vicinity and a number of fossils of recent age, clearly Pleistocene, were procured.

From Bongao we navigated through a labyrinth of islands along channels so narrow as to make it almost possible to lean over the side of the

boat and touch the branches of the trees, and we finally anchored in the narrow straits between Siasi and Lapac Islands. We had but one or two hours of daylight at this point, but a short excursion inland gave us a fairly good idea of the geology and soil of Siasi. The soil, as in Sulu, is a rich, red volcanic material, and the underlying rock, wherever I saw it, was andesite or basalt, which is frequently difficult to classify exactly, because of the weathering to which it has been subjected. Very little timber is seen on this island, at least not on the side at which we touched, and there are no large streams. However, a dense growth of cogon grass prevents serious damage from erosion. If this grass were not present, loss would surely result owing to the lack of forest. On the other hand cogon, as in other parts of the islands, is a serious menace to agriculture. It is usually the custom of the natives annually to burn off this grass, but this method only affords temporary relief. A better way and one which is being practiced with success in many localities is to plow the cogon under for two or three seasons, when the roots rot and not only is the grass killed, but the soil is further enriched.

The next point visited was the large and geologically little known island of Basilan. A portion of this island was occupied by the Spanish government, which had a small naval station at Isabela on the north coast. This has been abandoned since American occupation and the place has consequently fallen into neglect and decay.

But little geographical exploration has been done in Basilan. Mr Dean C. Worcester and his party visited it about the year 1892, and the following is taken from his account.[8]

"Isabela, the capital of Basilan, is a small place of less than 1,000 souls. The only Spaniards there are the officials and the Jesuit priest. The town is on high ground, which slopes sharply down to the edge of the channel separating Basilan from the little island called Malamaui. This channel, although extremely narrow, is very deep, and large vessels can come close inshore. Tremendous currents rush through it with the ebb and flow of the tides.

"Isabela is a supply station for gunboats, the coal yard and magazines being located in Malamaui, just across from the town. To defend the important stores which they contain there is only a ridiculous old limestone fort on a neighboring hill, armed with two or three antiquated smoothbore cannon, and garrisoned by a few marines.

"The Moros of Basilan, locally called *Yacans*, have always borne a bad reputation, but at the time of our visit they were held in check by a remarkable man known as *Datu* (Chief) Pedro."

A picture of the fort mentioned above is shown on Plate XV.

Only two short trips were made into the country back of Isabela; the same basaltic flows and rich red soils exist here as in Sulu and Siasi. Vulcanism does not appear to be as recent in Basilan as in Sulu. At no place did I find that the streams had cut through the lava capping and exposed the sediments which I feel sure lie beneath.

[8] Worcester, Dean C.: The Philippine Islands and their People. Macmillan, (1901), 144.

LAKE LANAO AND VICINITY.

All of the work in the region of Zamboanga and the Sulu Archipelago which it was at all feasible to undertake at this time having been completed, we left Zamboanga, November 6, for Overton. As our vessel kept close to the coast, I was able to make some notes which throw considerable light on the geologic changes now going on. The west coast of Mindanao has very certainly risen in comparatively recent times. Near Point Blanca on the northwestern part of the coast I saw a fine example of a raised delta, the elevation amounting to at least 10 meters. The characteristic structure of the delta was clearly revealed by the extensive marine erosion which had taken place. There were also many fine terraces shown along this coast and their existence supports the other evidence.

The weather compelled us to run into a little cove near the point just off Dapitan. Of all the many inlets along the coasts of these islands I believe this to be one of the prettiest and most secure. No sign of an entrance can be seen at less than a kilometer away and certainly this point would be too obscure to pick up at night. We went through a channel not over 45 meters wide between walls which in the darkness I took to be limestone, and emerged into a splendid basin with water as clear and placid as a mountain lake and with high walls on nearly all sides.

By noon of the next day we anchored off the little stone fort at the entrance of Panguil Bay, which is in the extreme southwest corner of the much larger Bay of Iligan. The most conspicuous object at this place is Mount Malindang, an extinct volcano close to 2,700 meters in elevation lying to the west. Material from the slopes of this mountain is basaltic as I discovered by going up Panguil Bay in a *banca* in company with Lieutenant Laffamore, Philippines Constabulary, and a detachment of soldiers, landing at several points to enable me to go far enough inland to examine the rocks, as there are no outcrops on the coast.

Mount Malindang is an old crater the rim of which is broken down on the side toward Misamis. It is for the most part covered with a luxuriant mantle of timber forest; the soil on its slopes is of a rich red and is undoubtedly very fertile.

A number of Visayan colonies exist on the west side of Panguil Bay, but all the country to the east is Moro.

We left this point on the morning of November 11 and reached Camp Overton at a little after noon. Mr. Ickis was to join me at this point, but as he was detained by quarantine, Lieutenant Caffery and I went forward over the military road to Camp Keithley (745 meters) where the climate is much cooler than in the coast towns

There is very little coastal plain in the region of Camp Overton, the hills rising so abruptly that the road has to wind back and forth in order to make the ascent. The first part passes through raised coral reefs, in

which the species are for the most part identical with those growing in the sea below, but within about 300 meters the road cuts through basalt, and continues in this formation until Malabang on the southwest coast of this portion of the island is reached. Maria Christina Falls are situated but a short distance off the main road, a few kilometers out from Overton. Here the swift waters of the Agus River, which drains Lake Lanao, fall over a cliff 58 meters high and continue to the sea through a narrow gorge.

It has been estimated that sufficient power can be developed by these falls by means of turbines to run electric freight and passenger trains from Camp Overton to Camp Keithley and then around the lake and down to Malabang. Furthermore, the power from this and the Mateling Falls together should also be able to furnish electric light for a dozen towns and camps along this route.

The rock in the upper portion of the section at the waterfall is a hard, rather structureless basalt; below this comes a more or less loose volcanic conglomerate, or better, agglomerate, the geologic structure giving the most favorable conditions for fall formation. Maria Christina has about the same height and volume of water as the better known Majayjay Falls of Luzon.

The road, very soon after the fork to the waterfall, leaves the rather heavy timber. From here on it ascends a long, gradually sloping, quite open and rolling plain, resembling the western prairie of the United States

The Agus flows in a broad valley with gently sloping sides at Numungan and while at this point it has a fairly rapid current, it gives no intimation whatever of the terrible plunge a few miles farther on. A party of engineers is stationed at Pantar some distance beyond this point to look after the roads and bridges, and we spent two days here to examine the cuts along the road and river bank. Basalt is still the country rock here, but it has on top an extraordinarily thick mantle of weathered material full of basalt bowlders, and both in constitution and topography this simulates glacial morainal material.

From Pantar the road runs fairly straight for seven to nine kilometers across open rolling country to the "Keithley escarpment." Beyond this escarpment lies Lake Lanao. The road continues almost due south to the foot of this great wall, then turns practically due east and, keeping nearly parallel with it, climbs gradually to the top. From here it runs down a long, easy grade to the margin of the lake.

This escarpment is very striking, and is made up from top to bottom, as far as can be seen from its cuts in the road, of loose material, unsorted and with apparently no definite structure, forming a wall 155 meters high. A simple explanation of this phenomenon is not easy to find.

To the left, when facing toward Camp Keithley from the top of the embankment, rises the dark, heavily wooded mass of "Sacred Mountain"

some 300 meters higher. In the middle distance stands a prominent, grass covered bump known as "Signal Hill" and beyond lies the lake and still farther back the dark, volcanic range of the Butig Mountains on the southeast. To the southwest the striking peaks known locally as "Ganasi" appear.

Usually, when the visitor first sees Lake Lanao, if he has any curiosity at all, he seeks the most natural explanation in a volcanic region, namely, that it is a crater lake. There may be some resemblance to a crater rim on the south shore near Camp Vicars, but in other places there is no trace of it. I first was favorably inclined to the belief that it was a valley dammed by glacial wash and I found no trouble in likening the Keithley Escarpment to a terminal moraine. I was forced to abandon this hypothesis for reasons which will be stated in a paper on the geology of this region which is to follow. My provisional conclusion with regard to Lake Lanao is that it occupies an old basin, partly tectonic, partly caused by erosion, between the mountains; this basin has been dammed by lava flows and other volcanic materials from the mountains adjacent to it. Subsequent weathering has given the aspect of a pseudo-glacial till to the material forming this obstruction. The explosion-crater theory has occurred to me and some attention will be paid to it in this connection in the later geologic discussion.

Camp Keithley is situated partly on the brow of the escarpment of the same name and partly on the slope to the lake. The small village of Marahui lies on the lake shore on the west bank of the Agus. Here is the residence of the district governor and here too, the tribal court is held. This village also has a native market, so that Marahui is the best place in the whole lake region to see the Moro people.

Mr. Ickis joined the party in Marahui and we crossed Lake Lanao in a *vinta* with a large sail and awning made of some species of palm. It was almost nightfall when we ran into a small cove and landed, and in the darkness we began the ascent of 155 meters up the high bluff on which Camp Vicars is situated. This distance is between 4 and 5 kilometers. Three days later we set out for the Taraca River on the east side of the lake with an escort of twenty scouts, sixteen cargadores, and several guides. The country around Vicars is open and rolling and very similar to that south of Lake Lanao. Very little of the land is under cultivation.

On the second day we finally descended from the high bluff we had been following and crossed an estuary, thus saving many miles of circuitous travel. The low flats which border this side of the lake extend back for several miles. The trail on the other side of this estuary lies through paddies and swampy areas. Every morning during our march was clear and bright, but the afternoons without an exception were rainy.

The region through which we passed contains numerous Moro forts or walled towns termed "*cottas*" peculiar to the Lanao Lake district and to Sulu. The walls are several feet in thickness, made of earth, and protected by a dense hedge of bamboo growing at the top. A moat nearly always surrounds the *cotta* and a drawbridge of bamboo is provided. Bamboos, into the closed joints of which have been placed long, slender-barreled brass cannon, known as *lantakas*, are thrust through holes in the walls. The *lantakas* are imported from Singapore. We passed fifty or more of these *cottas* in our trip around this part of the lake. Some of them shelter only one or two houses, whereas others contain a score or more dwellings, mosques and other edifices, in fact an entire village. Each *datu* or sultan lives in his *cotta* with his family and retainers close about him, and there is constant petty warfare among the various chiefs.

On the fourth day we reached the Taraca River and stopped at the house of a friendly *datu*. His *cotta* was, perhaps, the most elaborate we had seen; an elevation is shown by fig. 1.

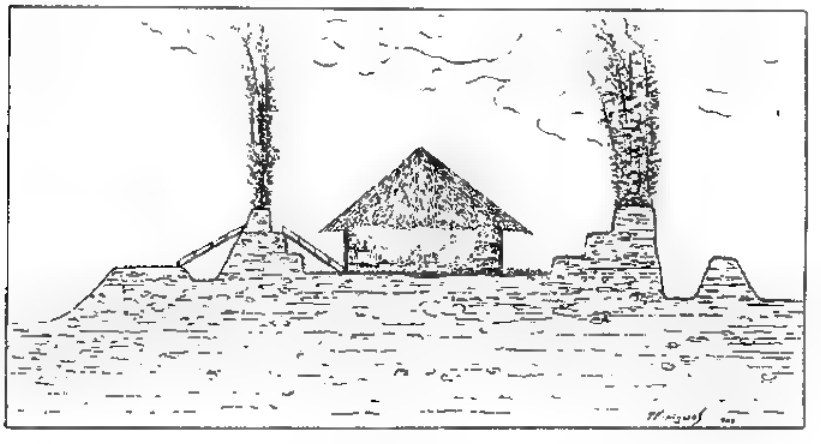


FIG. 1.

It was impracticable to ascend the Taraca River as far as the foothills to look for copper ore which had been reported from that point, because of the high water, the absence of trails along the bank, and the nature of the inhabitants. We did ascend for a distance of about 2 kilometers, but became almost hopelessly entangled in the ruins of old *cottas*, some recently destroyed by the Constabulary, others fallen into decay.

This condition caused us to continue our march to Camp Keithley and from here we again crossed the lake to Camp Vicars, from which point we set out for Malabang. The first portions of the road lie across an open, almost treeless country which affords a splendid view of the Bulduug Range which runs in a long, high, serrated line eastward from Malabang. Some six or eight extinct craters of different heights, arranged so as to resemble steps, are visible in this range.

The road next enters heavy timber and at about one half the distance to Malabang, crosses the steel bridge over the Mataling River. The falls of Mataling are not so high as those of the Agus, but are scarcely less

picturesque. The country rock is a basalt of more compact grain than at the other waterfall. The road runs into a very loose, black soil of sand and volcanic ash at a short distance beyond the bridge and continues in this formation to Malabang. This deposit of ash, at some distant date, issued from the now extinct Buldung craters. The most notable feature at Malabang is the line of cold springs issuing from the volcanic ash formation.

We next proceeded by trail from Malabang to Parang. Apparently all the country rock at Parang consists of basalt with well-developed columnar structure about 500 meters above the pumping station at the military post. Just south of the town the basalt sheet suddenly ends and sedimentaries, including coal measures, appear. Carbonaceous shales and certain fossiliferous beds indicative of coal deposits are here found, although no coal has as yet been opened up.

THE COTABATO REGION.

The country from Parang to Cotabato is rolling and but scantily timbered. The country rock consists of shales and soft sandstones dipping southward, that is, toward Cotabato. There are several small lakes in this region which are noteworthy, because of the great profusion of large, pink lotus and the abundance of ducks.

The difference between the topography in this region and that around Malabang is due to the absence of the lava capping which becomes thin just to the south of Parang. Whereas the streams in the lava country have a cross section like the following figure (fig. 2), those in the

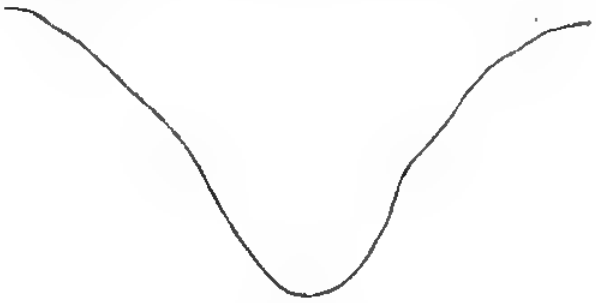


FIG. 2.

country to the southward beyond this sheet have more flaring sides to their valleys as is shown in fig. 3.

FIG. 3.

FROM COTABATO TO DAVAO.

The town of Cotabato is situated on the south bank of the north branch of the *Rio Grande de Mindanao*. It consists of a collection of low, white, Spanish houses fairly close together, with the usual native huts straggling about in the environs. Just south of and on the edge of the town is a limestone hill about 150 meters high from which a magnificent panorama (Plates XVI and XVII) can be obtained of the surrounding country. This hill is an outpost of a greater mass which is to be found to the south and which formerly was undoubtedly still more extensive; it is very remarkable in that it stands out in the middle of the great delta, which forms all the river plain from the mouth of the river back and even beyond Fort Pikit.

The most notable feature of the topography of this plain, beside the hill just mentioned, is the old terrace lines which swing along, but not always parallel to, either side of the river. These terraces are undoubtedly of marine origin, for close to Cotabato they are seen to be raised coral-reef shelves with the characteristic steep seaward slope of such formations. The evidence seems quite sufficient, to me at least, to suppose that the sea once swept far up this intermontane region which is now so filled with sediment. Indeed, I am convinced that it one time extended through to the Gulf of Davao, for in the stretch between the Pulangui River and Davao there are very recent sediments and volcanics which have closed up the passage.

Cotabato hill is composed of a cavernous limestone with a fair sprinkling of fossils, corals, gasteropods, lamellibranchs, etc., all of comparatively recent age, presumably Miocene, although no specific determinations have as yet been made.

Plate XVIII shows the interior of a native salt-making establishment at the lower end of the delta. Sea water is sprayed over glowing embers, the salt is precipitated and afterwards washed off and run through the large filter shown in the background of the picture. This filter contains wood ashes and earth. At the Moro foundry near Cotabato, bolos, krises, and many metal boxes of brass and silver are fashioned.

After some delay, we set out for *Datu* Piang's place at Cuderangan, some 50 kilometers above Cotabato. Here we learned from Lieutenant Younglof, Philippine Scouts, of oil seeping from the river bank about half way between Reina Regente and Fort Pikit and also near Pikit of a blue, plastic, oily clay which burns to a white color and is quite refractory. The Moros are said to come great distances to obtain this material.

Reina Regente is on a hill of limestone similar to that of Cotabato. It is a monadnock. The underlying foundation is sandstone which will doubtless be found to be a good water carrier; it is very probable that good conditions for artesian wells can be obtained at almost any point of the valley.

Fort Pikit, which dates from the Spanish régime, like Reina Regente, surmounts a limestone monadnock, but the latter is much higher than the one on which the former fort is situated. This is the farthest port on the Rio Grande.

From Fort Pikit we ascended to the end of navigation in the light-draft, stern-wheel steamboat which is used on the river. This point is some 50 kilometers beyond the fort, at the junction of the Kabacan with the Pulangui Rivers, the total ascent by steamboat being almost 200 kilometers.

The first three days of our march were through mud; we were continually forced to wade rivers, because we were following in the bed of the main stream, walking along the banks being out of the question, the first stop being at the junction of the Malabul and the Kabacan Rivers. We continued along the Malabul in a winding course, but making only 12 kilometers in a straight line in one day. A coarse, gritty sandstone and in places a typical conglomerate appear occasionally along the banks.

On the third day after we left Pikit, and six days' march from Davao, at an elevation of 365 meters, we reached the house of *Datu* Inkal, a Manobo chief. The geology in this region is not very prominent. The trail generally leads through dense underbrush. All the streams are filled with large bowlders of extrusive rock, evidently from the Matutan Range just ahead. The latter is represented on the Jesuit map as a long, continuous and rather formidable *Cordillera*, but it is nothing of the kind and, except for Mounts Apo and Matutan, it is merely a broken line of hills and quite low in several points.

The journey for the next few days can best be given by extracts from the diary.

December 16, 1907: Left *Datu* Inkal's at 7 a. m. Continued through jungle and over rolling country to an elevation of 580 meters where the trail goes through the pass. Halted and made camp beside a small stream. Rainy weather and leeches made traveling very disagreeable. The feet of the cargadores were bleeding freely, but they did not seem to mind it.

December 17, 1907: Broke camp at 7 a. m. Cloudy, elevation by barometer 472 meters. Crossed the Dalapnay River this morning. All the rocks for miles around this point appear to be similar, either fine-grained felsites, basalts and andesites or feldspar prophyries. Very little can be said geologically about this country at this time, as so little of it can really be seen. It apparently is extremely recent. Halted at noon at the Dalapnay River at a Manobo house and spent the afternoon of the 17th drying out our effects. Elevation at this point 412 meters.

December 18, 1907: All of this day we are going downhill through dry woods, for the most part consisting of small trees and little or no underbrush. Occasional basalt and andesitic bowlders are seen. The difference between this side (eastern) and the western side of the range is almost entirely due to the fact that the prevailing winds, moisture-laden from the Sulu Sea, give up their moisture on the western side of the mountains and the winds blowing off the Pacific lose much of theirs on the seaside of the mountains east of Davao. The appearance of these eastern-slope forests is not greatly unlike that of those in the Temperate Zone.

FIG. 4.

We halted for the night at 75 meters' elevation at Sinaulan Creek, where soft, brownish-gray sandstone and conglomerate is exposed.

December 19, 1907: Left camp at 6 a. m. Not much change either in topography or geology is apparent. Arrived at Digos, a small barrio on the coast of Davao Gulf, about 12 m., after a long walk over ground gently sloping to the beach. Here we spent the rest of the day and the night.

December 20, 1907: We sent our cargadores and guard on to Davao by trail while we took the launch *Bolnao* which stopped off this point at noon. We arrived at Davao about 7 p. m. after stopping at two or three plantations on the way and went ashore the morning of the 21st.

At Digos we obtained our first clear-cut view of Apo. The mountain stood out clearly and boldly, a sharp cone set to the south and back of an older truncated mass which had evidently blown off its head in some primordial paroxysm. On the southeastern side is a huge crevasse, from which puffs of a bluish-white vapor issue. Below 2,100 meters there is a dense jungle, a mass of green, but above this line the surface is all barren rock and apparently treeless, although when we ascended the mountain we found small bushes of blueberries.

The present high peak known as Apo did not pour the great mass of lava and rock over this entire region. The explosion crater was about 8 kilometers to the northeast. Fig. 4 shows a profile sketch of this mountain.[2]

A walk back over the plain behind Davao is interesting. About 300 meters behind the town, or about 2 kilometers from the beach, unmistakable signs of old beach lines are found, marked by one distinct terrace at least 15 to 23 meters above the flat on which the town is located. All this territory is made up of alluvial wash from the hills. The bowlders are largely andesitic.

Lieutenant Caffery left the party at Davao to return to Zamboanga. Without his assistance the reconnaissance, up to the point where Davao was reached, would have been impossible.

Daron, on the west side of the Gulf of Davao, was the starting point for the ascent of Mount Apo, the party consisting of Mr. Ickis, Mr. Goodman, who had just arrived from Manila, and Messrs. Carrigan and

[2] A good picture of Mount Apo will be found in the article on Volcanoes and Seismic Centers, in the Census of the Philippine Islands. (1903). 1, 201.

McCall, the last named having the kindness to furnish a launch to take us from Davao to Daron, and our thanks are extended to him for the courtesy.

We began the ascent of the first long, gradual slope toward Mount Apo on December 29. The trail first passes through hemp fields on the coastal plain and afterward it ascends gradually through a long, grassy slope which is strewn with occasional bowlders.

The first stopping place was at the house of Tankalin, the chief of the Bagobos. In appearance he and his people are very much like the Manobos. A short description of these people and one of their peculiar ceremonies has been given by me in a previous number of this JOURNAL.[50]

The remaining details of the ascent can best be given by extracts from the diary.

December 30: We are delayed because of lack of cargadores, the rear of our party not leaving until 10.30 a. m. We paused at 2.30 p. m. in the river bottom. Here some representative samples were collected from the bowlders in the agglomerate. These are largely angular and andesitic. The stream at this point is engorged in a steep-sided cañon, 300 meters deep. There are neither signs of ashes nor of lava in this cañon, although a great section is exposed. Everything points to there having been at some time a violent explosion, probably Krakatoan in magnitude. We pushed on to Pandaya, arriving 5.30 p. m. in a pouring rain and found one small, miserable hut.

The elevation of this place is 870 meters and in the early morning the temperature was 20°.5 C. During the night over half our carriers ran away, so we were left in a fairly precarious condition.

December 31: Messrs. Goodman and Ickis went ahead with part of the baggage; the remainder of the party remained to procure carriers, of whom we finally secured three, and to examine the rocks in the vicinity more carefully. There were five heavy packs, the lightest weighing 35 pounds. As Goodman and Ickis were also heavily loaded, all were compelled to assume the rôle of carriers.

The first, almost perpendicular rise of 180 meters was reached in a very short time, but the work was very trying to those who were unused to this kind of labor. The trail finally led along on a high ridge 300 meters above the water until nightfall.

January 1, 1908: About 10 a. m. some Bagobos came back on the trail as carriers, and soon after the camp of the advance party was reached. This place had been established by Major E. A. Mearns, Medical Corps, United States Army, who had been in this region collecting botanical and zoölogical material. The elevation as determined by the boiling point method is 1,854 meters; the barometer reading giving 1,662 meters. This camp is situated on a little shoulder of the ridge in a fair growth of timber and close by is a small stream of cold water, containing both iron and sulphur salts in solution. The summit of the mountain can be seen from here through an opening in the trees and the fumes issuing from the huge crevasse on the eastern side are also plainly distinguishable. (See Plate XIX.)

January 2, 1908: The trail first leads upward through the heavy timber in the mossy forest belt, and then drops into a small creek bed which it follows up to 2,250 meters; here it passes beyond the timber line and through a growth of small blueberry bushes and stunted shrubs finally reaching exceedingly rough

[50] *This Journal, Sec. A.* (1908), 3, 188.

ground; however, there are neither ashes nor lava. The pathway follows the south side of a huge crevasse visible from far below, and after following this for about 300 meters crosses to the north side and continues along it and around its head to a knife-edged ridge leading to the summit. This crevasse in some places is probably 20 meters deep and 250 wide, it has eight or ten vents from which vapors containing sulphur dioxide issue. A cone of fairly pure sulphur surrounds each vent; in individual cases these deposits may reach dimensions of several thousand kilos; possibly there may be 400 metric tons of this material altogether. It probably could not be handled conveniently.

A clay tablet with the inscription—

La única Expedición a Volcan Apó
1880
Montano y Rajal

exists at about 2,350 meters' altitude.

Our party reached the summit at a little after noon. So far as is now known, this is the highest mountain peak in the Philippine Archipelago. The altitude was determined by two trials with the boiling point method, which gave respectively 2,956 and 2,902 meters. The barometric reading at the first trial showed 2,811 meters, which number is, of course, considerably in error. The old Spanish Coast and Geodetic chart of this region gives 3,143 meters, but work now being carried on by the Coast and Geodetic Survey of the United States shows that the Spanish work in these waters is in error.

The records of several parties are found on the summit, the earliest encountered being that of Schadenberg and Koch, 1882. None of the Montano expedition of 1880 was visible and possibly the tablet at about 2,600 meters' altitude has been carelessly or maliciously removed from the top where it was originally placed.

The highest point of the mountain, as determined by measurement, is reached by crossing a low sag to the next pinnacle, and here is placed a cairn containing a brass tube with a screw top marked "S. C." Inside is a neat scroll of the Sierra Club of California, duly stamped with its seal and signed by its president, John Miner. This scroll was deposited in the month of October of 1904, by Dr. E. B. Copeland, formerly of the Bureau of Science. Our party was the first to sign on the register.

Sights, with the transit, were taken at all prominent points of the topography and boiling-point determinations were also made, although the work was much hampered by fog. The weather cleared in the late afternoon and we were able to observe the panorama from the summit.

The Gulf of Davao was plainly visible with its island and coves, encircled by dark green wooded mountains and long volcanic slopes. The Rio Grande cuts across the foreground as a silver streak, extending far in the midst of many folds of green which continue without break to the skyline to the westward. The vast extent of the jungle in this island is very strongly impressed upon the observer. Mount Matutan is visible some 62 kilometers away, appearing as an isolated cone. It was sighted with a level, and appears to be but little lower, even at that distance, than the point on which we stood. If the curvature of the earth is taken

into consideration, it is quite possible that Matutan will be found to be appreciably higher than Apo. No record, so far as I know, of an ascent of the former exists.

Mount Apo shows a circular depression suggestive of a crater at the top and, although the rock is igneous and gases issue from a great fissure in the side of the mountain, I would not, in the strictest sense, term it a volcano for the following reasons:

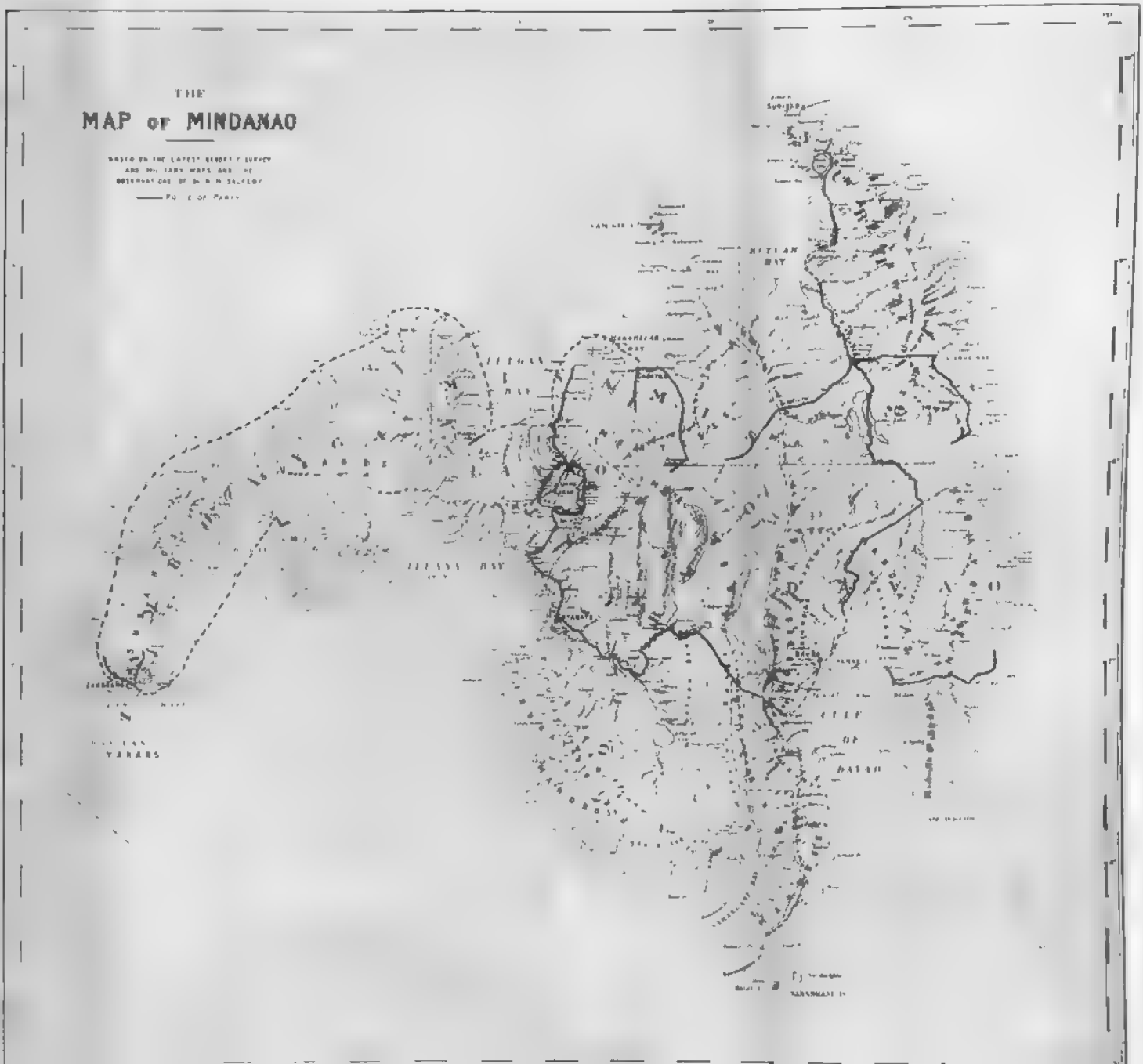
1. There are neither ashes nor signs of lava outpourings; the rock on this part of the mountain is rather more holocrystalline than effusives usually are.

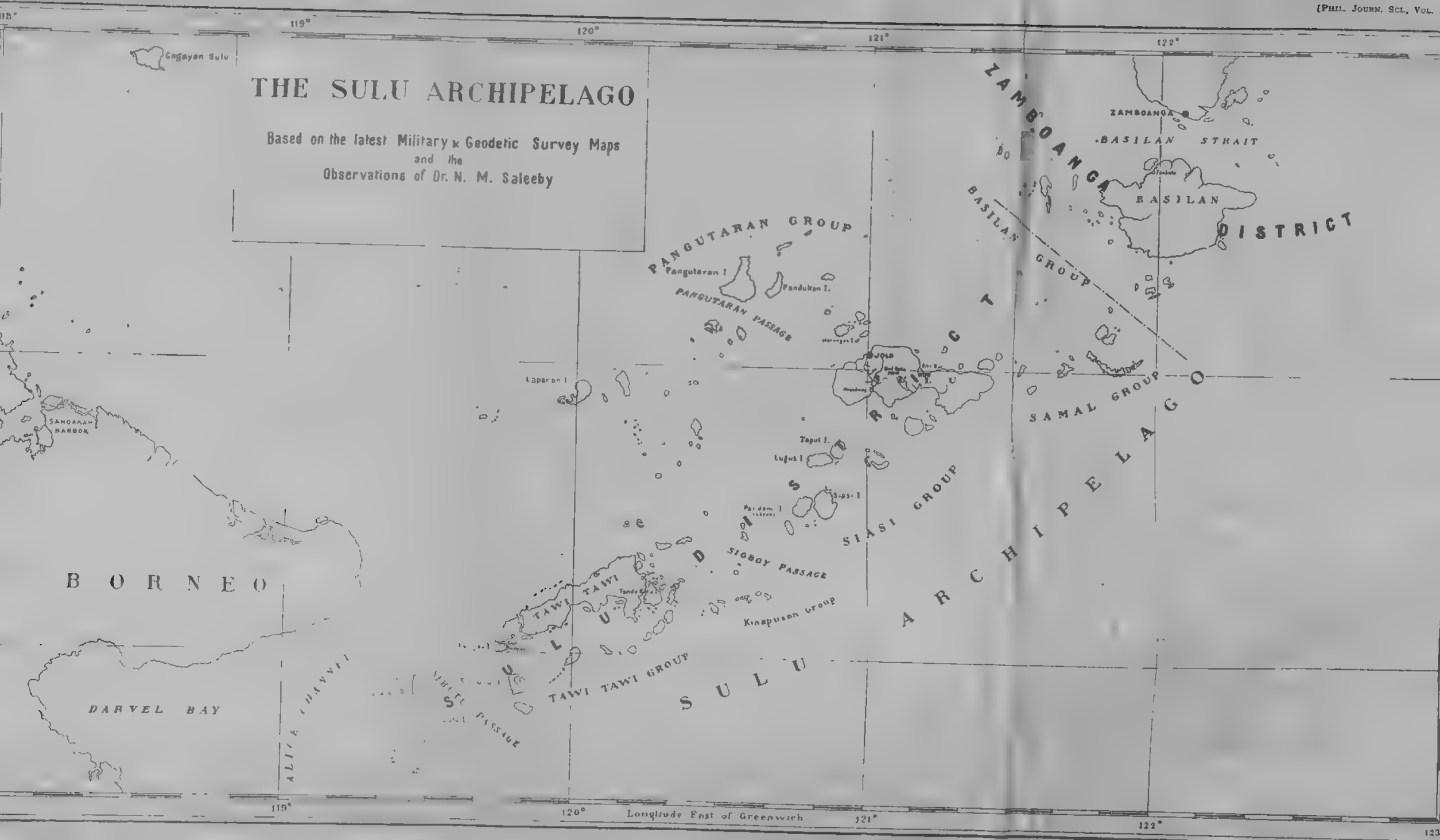
2. The "crater," as it apparently shows no signs of the products of vulcanism about it, might be explained as a water erosion cirque; this question will be discussed more at length in the paper on the geology of Mindanao.

3. The structure of the mountain is schistose due to pressure and shows clearly that this is a structural peak. Plate XX shows this schistosity and its antiolinal course.

The morning temperature at the summit was 8° C. A small lake exists on a shoulder of the mountain, apparently about 500 meters below the summit; it was not visited. The return to Davao occupied two days. Here I left the expedition to return to Manila, and Messrs. Goodman and Ickis continued the reconnaissance from Davao to Surigao by way of the Agusan River.

ILLUSTRATIONS.


THE
MAP OF MINDANAO


THE SULU ARCHIPELAGO
Based on the latest Military & Geodetic Survey Maps
and the
Observations of Dr. N. M. Saleeby
Cagayan Sulu
ZAMBOANGA
BASILAN STRAIT
BASILAN
ZAMBOANGA DISTRICT
PANGUTARAN GROUP
Pangutaran I.
Pandukan I.
PANGUTARAN PASSAGE
BASILAN GROUP
JOLO
SULU ARCHIPELAGO
SAMAL GROUP
Laparan I.
SANGAAAN MARBON
Tapul I.
Lugus I.
SIASI GROUP
Siasi I.
Pandam Islands
SIBOGOY PASSAGE
BORNEO
TAWI TAWI
Tandu Bas
Kinapusan Group
TAWI TAWI GROUP
SULU SEA
DARVEL BAY
ALICE CHANNEL
SIBUTU PASSAGE
119°
120°
121°
122°
Longitude East of Greenwich

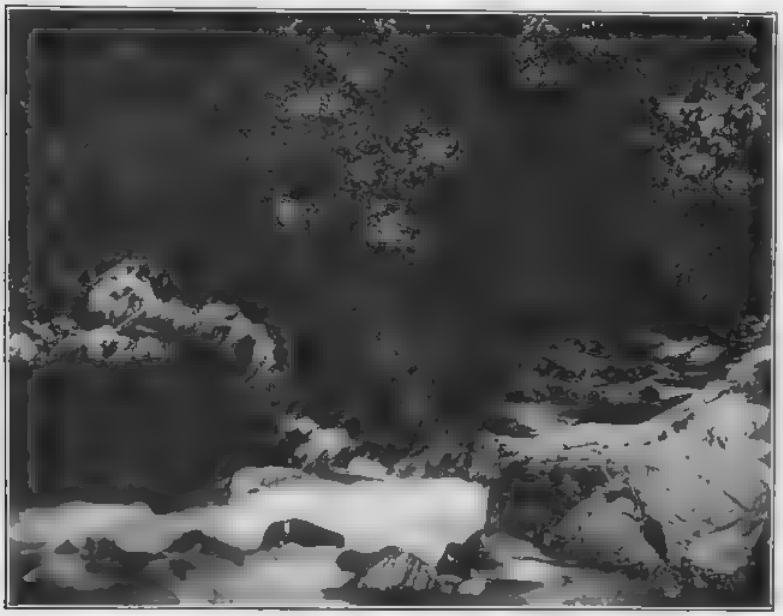


PLATE III.

PLATE IV.

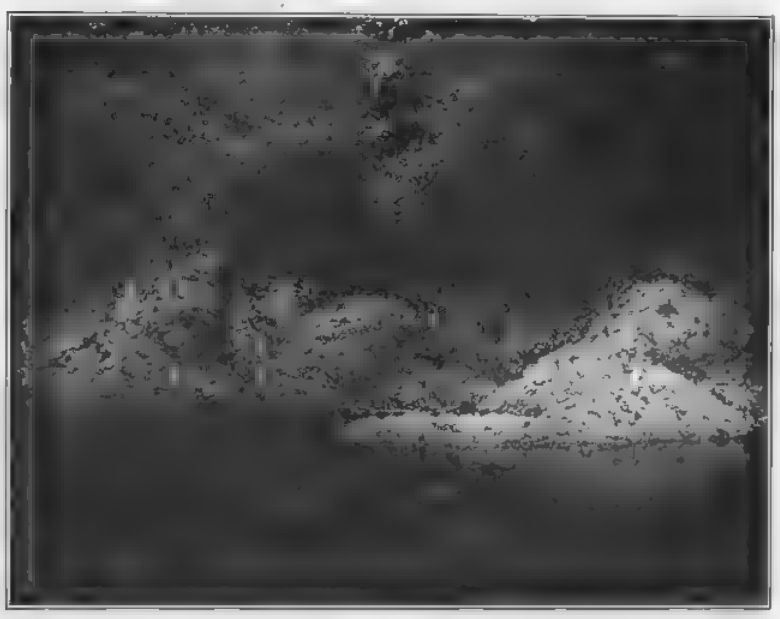


PLATE V.

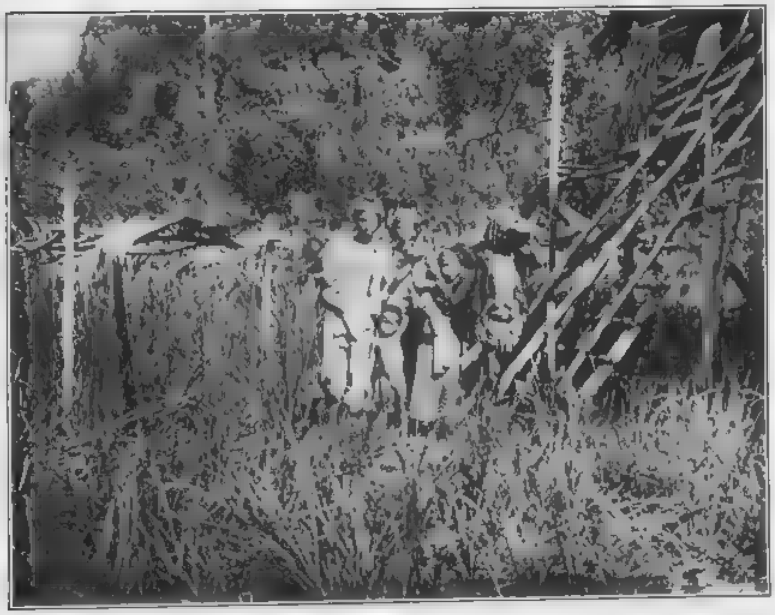


PLATE VI.

PLATE VII.

PLATE VIII.

PLATE IX.

PLATE X.

PLATE XI.

PLATE XII.

PLATE XIII.

PLATE XIV.

PLATE XV.

PLATE XVI.

PLATE XVII.

PLATE XVIII.

PLATE XIX.

PLATE XX.

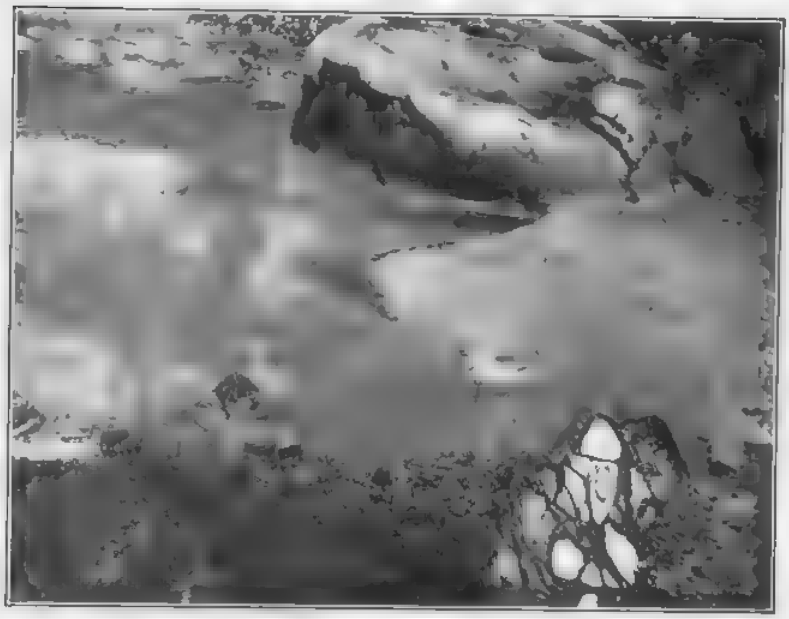
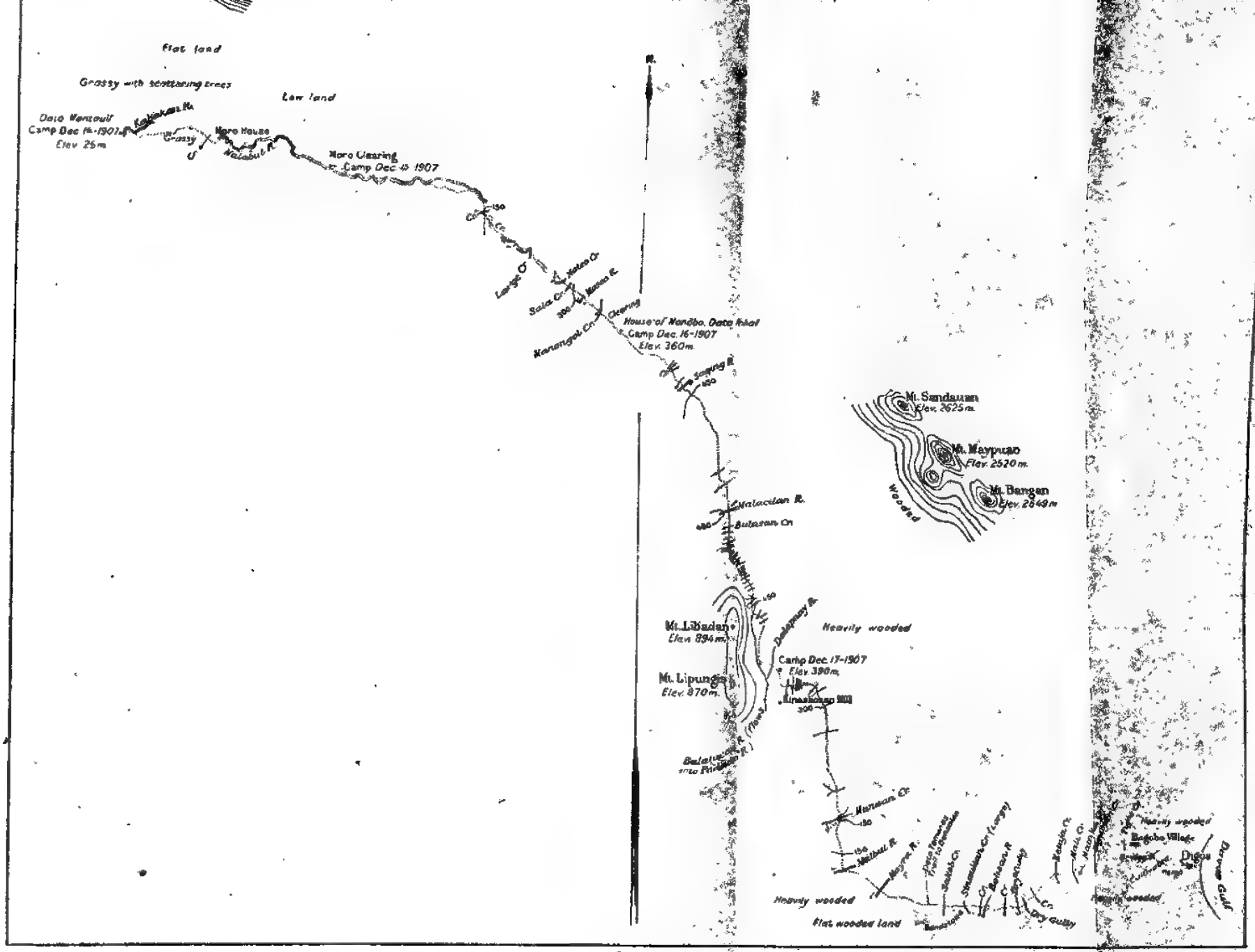


PLATE XXI.



DEC 14-20-1907

Scale

Kilometers

Statute Miles

CONTOUR INTERVAL 150 M.

TOPOGRAPHY BY HARRY M. ICKIS

PLATE XXII.


Mt Apo
Cogon with scattering trees
Cogon grass
DAVAO
GULF


Mt Apo
Cogon with scattering trees
Cogon grass
DAVAO
GULF
Mt Baltod
Mt Tangpurun
475 m (about)

A RECONNAISSANCE FROM DAVAO, MINDANAO, OVER THE DIVIDE OF THE SAHUG RIVER TO BUTUAN, INCLUDING A SURVEY FROM DAVAO TO MATI.—NARRATIVE OF THE EXPEDITION.

By MAURICE GOODMAN.

(From the Division of Mines, Bureau of Science, Manila, P. I.)

INTRODUCTION.

Before beginning the reconnaissance from Davao to the Agusan River, I decided during a short absence of Mr. Ickis to make a journey from Davao to Mati, in order to collect geographical and geologic data on the traverse across the Pujada Peninsula. The overland route was taken both going and coming.

THE PUJADA PENINSULA.

The start was made on January 16 from Piso on the west coast of the Gulf of Davao, in a small *vinta* or sailboat, to the Moro village of Sumlug where three Moro guides and carriers were obtained, thence we went to Koabo, a deserted village with only a few dilapidated huts and a small number of coconut trees, farther south on the east coast of the gulf.

The coast line of this portion of Mindanao was at this time being surveyed by a party from the Coast and Geodetic Survey. Therefore, I confined my topographical sketching to the interior. The distance between the Gulf of Davao at Koabo and the town of Mati on Pujada Bay is approximately 21 kilometers, and between the two coasts the country is entirely uncultivated and uninhabited. The trail for the most part leads over a slightly hilly country, covered with a comparatively thin forest growth which, however, is sufficiently dense to make observations upon prominent points at any distance from the path almost impracticable. The ridge forming the backbone of the peninsula which terminates in Cape San Agustin, is rather low at this place, being less than 200 meters above sea level where the trail crosses the divide. The core of this ridge is of igneous origin and has undergone minor metamorphism. The original, unaltered diabase, which is the most common rock encountered, presents the typical ophitic structure and contains in addition to the

feldspar and ferromagnesian minerals, a considerable proportion of secondary quartz and microscopic crystals of apatite.

A fractured, but hard and siliceous noncrystalline rock, which under the microscope plainly exhibits a flow structure, is also encountered. This is undoubtedly the surface phase of the igneous flow. Another phase of the basal rock is a chlorite schist, reddish-brown in megascopic specimens, and containing a large amount of secondary quartz. This rock is probably an alteration product of the original diabase.

Both coasts of the peninsula are composed of sedimentary strata. A pink limestone intersected by numerous veinlets of calcite rests on the west flank of the igneous intrusion, while the east coast is mainly conglomerate and brown shale. At Mount Badas these beds attain a thickness of over 180 meters and dip about 45° toward the southwest.

East of Mati and between the Bays of Pujada and Mayo is a stretch of agricultural land about 13 kilometers in width. The greater portion of this consists of a table-land elevated about 30 meters above the general level of the present coastal plain. The plateau is terminated to the east and west by steep slopes; on the south, a narrow spit of land, which at high tide is but very little elevated above the sea, connects this table-land with what originally was undoubtedly an island off the main coast, but is now the southern point of the peninsula which separates Pujada Bay from Mayo Bay.

The country becomes more rugged and mountainous east of Mayo. The geologic formation is entirely sedimentary. The ridge extending from Mount Mayo to the bay of the same name, terminates in a bluff of conglomerate, dipping at an angle of approximately 30° to the east. At the coast line, the conglomerate presents a section of about 150 to 200 meters in thickness, and is composed of small, igneous bowlders. The wave action on this coast is extremely powerful, particularly during the period of the southwest monsoons, and the resulting erosion of the softer beds is plainly marked.

At a place called Lucatan, about midway between Mayo Bay and the town of Tarragona, the formation changes from conglomerate to limestone, the latter apparently overlying the former. The limestone is coralline in structure and is plainly an old reef rock that has been elevated to its present height by the general uplift of the coast. The dip and strike of this formation could not be ascertained, but as it is succeeded on the east by another outcrop of conglomerate, dipping about 14° in the direction S. 77° E., it must be inferred that the limestone lies unconformably on the underlying conglomerate, or else that the uplift was succeeded by a later stage of subsidence. For lack of supporting evidence of this latter theory, I am inclined to believe the existence of an unconformity the more probable.

An outcrop of a seam of coal about 85 centimeters thick exists on the

south bank of Cabatoc Creek, about 9 kilometers north of the town of Tarragona. The seam dips at an angle of about 15° in the direction S. 50° E. A conglomerate or coarse sandstone immediately underlies it, while above lies a soft, brown shale, which in turn is overlaid by an impure limestone.

The coal shows traces of its original, woody structure, is separated by several clay partings, is lignitic in character and composition, and yields the following analysis as determined by the division of chemistry of the Bureau of Science:

	Per cent
Water	11.47
Volatile combustible matter	23.87
Fixed carbon	14.08
Ash	50.58
Calorific value in calories	1,750

The sample submitted was obtained from the only observed exposure, and the low grade of the coal as shown by the analysis must therefore be partly charged to the long period of weathering which such a surface outcrop must naturally have undergone. However, at best, because of the thinness of this the only known outcrop, the clay partings which subdivide it and its long distance from any good port, the deposit must be considered of very doubtful commercial importance. Its chief value lies in indicating that conditions favorable to the formation of coal have existed in this region, and further prospecting may reveal more promising deposits.

After making this short reconnaissance, I returned to Davao, from which point the general plan was once more taken up by the reconnaissance to the Agusan River and down this stream.

DAVAO TO THE AGUSAN RIVER.

Mr. Ickis having joined me, we left Davao on January 31, having received as guide from the tribal-ward headman of Lasan the services of Comansing, his Moro chief of police. We traveled by launch for about six hours in a north-northeasterly direction to the mouth of the Tagum River, and up the latter about 10.5 kilometers to a small aggregation of huts known as Binemgan. The coast line as far as we could observe was thickly wooded, and only occasionally patches showed signs of cultivation. The inhabitants of Binemgan are for the greater part Manobos.

In passing through the Straits of Pakiputan, we encountered a fleet of seven pearling vessels actively employed upon an unusually rich bed of pearl shells deposited upon a narrow shelf on the west coast of Samal Island. We learned at a later time that the bank was stripped in about six weeks, and while valuable beds still remained they were at depths which the local divers with their apparatus considered unsafe.

The route was began at Bincungan and carried up the Tagum and Sahug Rivers across the divide to the Agusan River, then down the latter to Talacogon.

Our facilities for this sort of work were extremely small. We had no means of obtaining with any degree of accuracy the speed and therefore, the distance traveled. We carried one pocket aneroid and one hypsometer. Unfortunately the former was accidently broken on the fourth day out, so that we had to estimate all altitudes, checking them when opportunity offered with the hypsometer and vertical angles taken with a Brunton Pocket Transit. However, I should say that considering the disadvantages under which we worked our combined estimates checked surprisingly well with whatever more or less reliable data we could obtain.

We carried a chronometer and transit for the purpose of determining the geographical position of various points on our route, but the rate of the chronometer and some other essential notes were irredeemably lost when Mr. Ickis was murdered, so that these checks are now impossible.

The Tagum River is navigable for launches from Bincungan as far as the barrio of Biaksabangan. The river narrows down from about 90 meters at the former place to approximately 60 at the latter, and its banks, which are about 3 meters above high-water level, are partly cultivated in hemp.

Biaksabangan is the junction point of the two main rivers, which go to form the Tagum. The western branch, the Libagano, rises on the south flank of the Panamboyan range and flows southeast towards Biaksabangan. Very little is known in regard to the valley of this river, but it is supposed to be entirely uncultivated and to be inhabited by Atas and other savage tribes.

We left the launch at Biaksabangan, and continued our journey up the Sahug River in a *banca*. This stream is about 30 meters wide at its mouth, and flows in a tortuous course through banks elevated about 5 meters above the water level. These consist of a brown and blue clay soil, overlying sandstone. The beds are practically horizontal with the exception of minor folds of very limited extent.

The people are long-haired Mandayas, and are engaged for the most part in the cultivation of small patches of hemp, for which their sandy clay soil seems to be well adapted.

The first stop on the Sahug was at the barrio of Kambanguy. Men to row us further up the stream were secured with great difficulty, and only after the headman of the village provided the party with men armed with spears and shields. The river is only about 15 meters wide at this place and continues to grow narrower up to the barrio of Kalihdan, about 4 kilometers up the stream. The banks rapidly become more thinly populated, and the cultivation grows proportionately thinner.

We observed dark, boggy, deposits, consisting largely of leaves, twigs, and branches at numerous places along the stream. These deposits were 0.6 to 1.3 meters thick, and some at least showed distinct planes of sedimentation. They were plainly of quite recent deposition, and further convinced us of the fact that this region is one of recent elevation.

We started from the barrio of Kalilidan on the fifth day of the journey with twelve men all armed with spears and two with shields. No Moros live along the Sahug River north of Kalilidan, and we met no one who could speak Spanish until we reached Veruela on the Agusan River, where some of the municipal officials talk that language.

The *bancas* were abandoned about 3 kilometers north of Kalilidan at a small barrio termed Mantinlad. The river widened from about 15 meters to approximately 30 between Kalilidan and Mantinlad, but it also shoaled very much, so that a short distance beyond Mantinlad, it became impossible to float a loaded *banca*. Several more deposits of black, semidecomposed and partially carbonized vegetable matter resembling peat were observed on the banks.

We traveled in a northeasterly direction from Mantinlad through a rather thick forest, climbing two hills about 75 meters high, and returning to the Sahug, where we crossed over to the right bank. The ground was too thickly covered with vegetation to permit of determining the underlying geologic formation, but to judge from its configuration, from occasional bowlders and from the character of the soil, it is presumably sedimentary and probably an argillaceous sandstone. In the bed of the Sahug River we picked up numerous bowlders of coralline limestone and calcareous conglomerate of apparently such recent origin as to bear out the theory that this part of Mindanao has been elevated above sea level in a comparatively recent period.

The boundary line between the Mandayas and the Mangguangs is at approximately this point. The Mangguangs differ but little from the Mandayas in personal appearance. Their dialect is not quite the same and their habitations are a departure from any we had previously observed. For the most part their villages consist of small groups of dwellings built on high posts, strongly braced to prevent swaying in high winds or earthquakes. Access to the house is gained by means of a long, round pole, about 12 or 15 centimeters in diameter, which passes through a hole in the floor 4.5 to 6 meters above the ground. This primitive scaling ladder is set at a very steep angle, and instead of rungs it has notches about 5 centimeters deep cut into the front of it. The floor space is about 3 by 7.5 meters, and the house is usually entirely open at the sides with the exception of about two or three widths of boards immediately above the floor. Although these people all possess long and highly ornamented spears and bolos, the bow and arrow is the more commonly used weapon.

The unusual elevation of their houses is commonly supposed to be for the purpose of sleeping out of reach of a spear. However, the floors which might be made of boards as readily as the sides are in all the houses we saw made of split bamboo. Whether or not this is the main purpose for elevating the houses, they serve well as watch towers to guard the *camote* and corn patches which usually surround them.

Our carriers deserted at this point, and when after great difficulty we had secured others, the journey was continued northward through a practically uninhabited country, for the most part along a thickly wooded ridge about 100 meters in elevation. Outcrops were very few and far between, but from pieces of float we determined the underlying formation

to be a yellow limestone of coralline origin, ranging in hardness from a very soft, porous variety to one almost holocrystalline.

On February 7, the route continued in a northerly direction for a great portion of the distance in the bed of Budyan Creek, which is a branch of the Magum River. The latter is about 30 meters wide where we crossed; it flows in a southeasterly direction into the Salug River.

During this entire day we encountered only outcrops of an impure, compact, and greenish appearing sandstone containing a small amount of calcite. These beds, which evidently underlie the limestone, strike in a general north and south direction, and dip at steep but varying angles to the westward.

The route changed more to the northeast on the following day, ascending a densely wooded ridge termed Mount Kinabuungan, which we estimated to be about 400 meters above sea level at the place where we crossed it. This was the highest elevation attained on the trip to the Agusan.

Mount Kinabuungan forms part of the range which extends from Mount Panamboyan in a northeasterly direction to the Agusan River. This range constitutes the northern boundary of the Salug River watershed. The inclination of the sandstone beds swings through an angle of about 45° in direction, the dip changing from west to northwest and the strike becoming approximately parallel to the Kinabuungan mountain range.

An outcrop of fossiliferous clay was observed on the Mauntoc River, at an elevation of about 175 meters above sea level, overlying a conglomerate which in turn overlies the sandstone. The fossils were all of marine shells, apparently of very recent origin, and many of them had been so little disturbed and so well preserved that they still retain their original color and polish.

Travel was necessarily slow at this point owing to recent rains because of which the rivers were swollen, so the party was compelled to spend the night on the bank of the Manacum River.

The clay beds on the following day's march showed some signs of increased dynamic action. They became somewhat folded and cleavage planes developed, perpendicular to the bedding planes. We traveled almost due east until we again encountered the Salug River which we crossed at the barrio of Banglasan. At this point the stream is about 15 meters wide, flowing between clay banks about 5 meters high. Banglasan, which is about 200 meters above sea level, is the largest barrio we entered since leaving the Tagum River.

One of the affluents of the Salug called Tabunanan Creek was the line of march on the next morning almost to the barrio of Hoagusan, which was reached early in the day. This place is situated on the divide between the Salug and Agusan Rivers, and according to our hypsometer is 240 meters above sea level. The beds between Banglasan and Hoagusan consist of the same sedimentaries which had previously been encountered.

but just after leaving Banglasan one or two small bowlders of a basic, igneous rock were seen. For lack of any positive evidence to the contrary it is supposed that these bowlders originated in the underlying conglomerate and had worked loose from the matrix on weathering and disintegration.

The descent from the divide to the Agusan River was made along the bed of Banglag Creek. This stream is only about half a meter wide near its source, but is fed by numerous branching streams, so that in the 7 kilometers of its course to the Agusan it grows to a stream about 6 meters in width and more than a meter in depth. The descent is fairly uniform in grade, and the sides of the gorge it has eroded are high and steep, as far as the valley of the Agusan.

The Banglag runs over a series of strata beginning with conglomerate and sandstone lying practically level near Hoagusan, then over fossiliferous clay beds striking N. 15° W. and dipping 35° northeast. These beds are in turn underlaid by shale striking N. 20° E. and dipping towards the southeast, and in the Agusan Valley by a coarse, calcareous sandstone, which strikes approximately N. 60° E. and dips about 25° to the southeast. This last sandstone contains large fragments of marine shells in a calcareous matrix.

No evidence of marked or recent earthquake disturbances were observed on the route followed by the party, probably because the subsequent heavy growth of underbrush has erased or hidden the scars and fissures that may have been caused thereby; however, the territory traversed is supposed to be a region of violent seismic activity. The Rev. M. Saderra Masó, S. J., in writing of the seismic center of the Agusan River states:[1]

"This focus is possessed of great seismic activity, as is evidenced by the long series of earthquakes observed and carefully recorded by the Jesuit missionaries of that region since the year 1890. In June, 1891, a violent earthquake was the beginning of a long and fearful seismic period. This earthquake produced most serious destruction to the houses and ground; fortunately owing to the wildness of the country, there was little loss of life or of property. The falling banks of the river dammed it in many spots. Long and wide fissures were opened everywhere, especially on the hills separating the Agusan Valley from the Hijo and Saluog Rivers, which empty themselves into the Davao Gulf. The earthquake lasted several minutes, and during this time, says an eyewitness, the ground was moving as the troubled sea. During the following months, or during more than a year, the earth trembled with more or less force every day. In June 1892, there was a second violent disturbance, shaking the same region and renewing the havoc of the preceding year. These two earthquakes shook the Island of Mindanao nearly from end to end, and were fairly perceptible in the eastern Visayas.

"Since these dates small shocks have been more frequent in this region than in any other part of Mindanao. Their cause is probably geomorphic rather than volcanic. There are unmistakable signs that the southern coast of Mindanao,

[1] Volcanoes and Seismic Centers, in Census of the Philippine Islands (1903), 1, 201.

comprised between Cotabato and Panguiān Point, the most southern one of the island, is at present undergoing subsidence, while, on the other hand, an upheaval seems to be going on in the northeastern and Pacific coast of the island. The southwestern part of the epicentral region, especially the hills or low ranges where the widest fissures were opened, may be considered as the junction between the eastern ranges of Mindanao, running from Surigao to the San Agustin Cape, and the central one, stretching from the Dinata and Sipaca Points in the north, to Panguiān Point in the south. All the rocks in this range, through which run the Sabug and the Tubūan Rivers, are of madrepore and polypus of recent formation, alternating with clay beds and limestone strata."

MONCAYO TO BUTUAN ON THE AGUSAN RIVER.

The Agusan River, just below the town of Moncayo, was reached on the afternoon of February 10, the eleventh day after leaving Davao. The river at this place had an average width of 41 meters and was about 1.6 meters deep at the time of our visit. There was a surface current averaging 3.86 kilometers per hour, equivalent to a discharge of 64.5 cubic meters per second. Moncayo consists of perhaps forty houses and is inhabited by Ibabaos.

The map of the river which accompanies this report shows the town of Moncayo to be situated on the right or east bank of the Agusan River, about 134 kilometers south-southeast of Butuan. The actual distance to Butuan, as measured along the course of the river, is approximately 250 kilometers. Our bearings were obtained with a Brunton Pocket Transit, while the distances were gauged by time.

The party left Moncayo on the morning of February 13, floating downstream in a small boat. Fortunately we had the current of this long river in our favor, otherwise, particularly during the period of high waters in which we traveled, progress would have been extremely slow and laborious. The banks are nearly everywhere 3 to 10 meters high and as the valley of the Agusan is very wide and flat, observations could not be obtained on peaks or mountains.

San Rafael, a small barrio of the town of Jativa, was reached in the afternoon.

The people of San Rafael resemble closely the Ibabaos or Mandayas from farther up the river, but they call themselves Agunitanos, which is probably a local name, for we heard it nowhere else. They possess a corrugated iron-roofed church, the first we had seen since leaving Davao, but this as well as all the other buildings in the barrio is in a very dilapidated condition. The dwellings are constructed more like the typical Filipino hut, and in place of the high, open-walled houses with scaling poles leading up to them, such as are constructed everywhere between the Sabug and this place, all, with only one exception, had nipa walls and ordinary, short, bamboo ladders.

The banks of the river between Moncayo and San Rafael consist almost entirely of a clay shale lying practically horizontal. A bank of fossiliferous blue shale about 9 meters high exists at a place below the barrio of Tagusap, on the west side of the river. The fossils which are all of recent marine origin are extremely numerous and splendidly preserved.

A considerable amount of chalcedony, and igneous bowlders, mostly andesite, carrying secondary quartz and zeolites was observed at the junction of the Agusan and the Buoy Rivers. These rocks are brought down by the Buoy River from the mountain range which separates the drainage areas of the Agusan River and the Pacific Ocean. We panned some gravel from near the mouth of the Buoy, but could find no colors.

We left San Rafael early the following morning, floating downstream with the current and arriving at the municipality of Veruela at 7 o'clock at night. The river was straighter and the banks somewhat higher and more timbered. The Agusan is wide and deep at this part of its course, and affords a splendid avenue for transportation, but the country is so thinly populated that very few *bancas* were encountered.

In spite of the fact that this region is one of the most marked centers of frequent and intense seismic disturbances, the beds of soft clay and shale which we found outcropping on the river banks lie practically horizontal and show no effects of dynamic action. An estuary leading into a small pond which drains into the Agusan is situated at a place called Maasin, about 3 kilometers south of Veruela. An outcrop of soft, blue shale, containing a large variety of fossil shells in an excellent state of preservation occurs on the west bank of this estuary. These fossils, as well as those collected at Tagusap and other places, have been sent to Dr. Smith at Leiden, Holland, for study and comparison.

Veruela was the first so-called Christian town that we entered after leaving Davao, and it is the largest on the upper Agusan. I should judge its population to be about 5,000, nearly equally divided between Christian Visayans and *conquistas* or Mandayan converts. The principal pursuit of the inhabitants is the cultivation of abacá and rice.

The river at Veruela is considerably wider and deeper than at Moncayo, but not as swift. According to our rough measurements it is 61 meters wide, about 2.3 meters deep, and has a surface velocity of approximately 2.17 kilometers per hour. These figures correspond to a discharge of about 95.5 cubic meters per second as against 64.5 near Moncayo.

The banks of the river about a kilometer below Veruela gradually become lower, until they disappear entirely; the main channel is choked with vegetation and the current is very much reduced. In place of the splendid river, there is a swampy jungle with alternating, swift, tortuous, and narrow channels and again wider stretches of almost calm water. This portion is termed Lake Linao and is a part of the Agusan River system. The lake is probably formed by a local depression of the surface, attendant upon a movement of the earth's crust. There are several lakes in this basin, but their boundaries are not well defined and a channel connects all.

Clavijo was reached in the afternoon. This town consists of one church with corrugated iron roof, and five dilapidated nipa huts, all but two of which were abandoned at the time of our visit.

The course of the next day's travel was very much the same as the preceding. A submerged basin was traversed which appears to be about equally divided between low, swampy ground and lakes, the latter being connected one with another by narrow and crooked channels which intersect the swamp in all directions. The main stream of the Agusan River was reached about noon. At this point it is about 65 to 95 meters wide. The banks are very low, and in places, during high water, only the tops of the high grass indicate their position. This region is entirely uninhabited. We arrived at Martires after nine in the evening, and during the entire day did not meet a single individual nor pass a single habitation.

Martires is a fair-sized town inhabited largely by *conquistas*, whose chief occupation is the cultivation of abacá. It is but an hour's travel from Talacogon, and so we arrived at the latter municipality early in the morning of February 18.

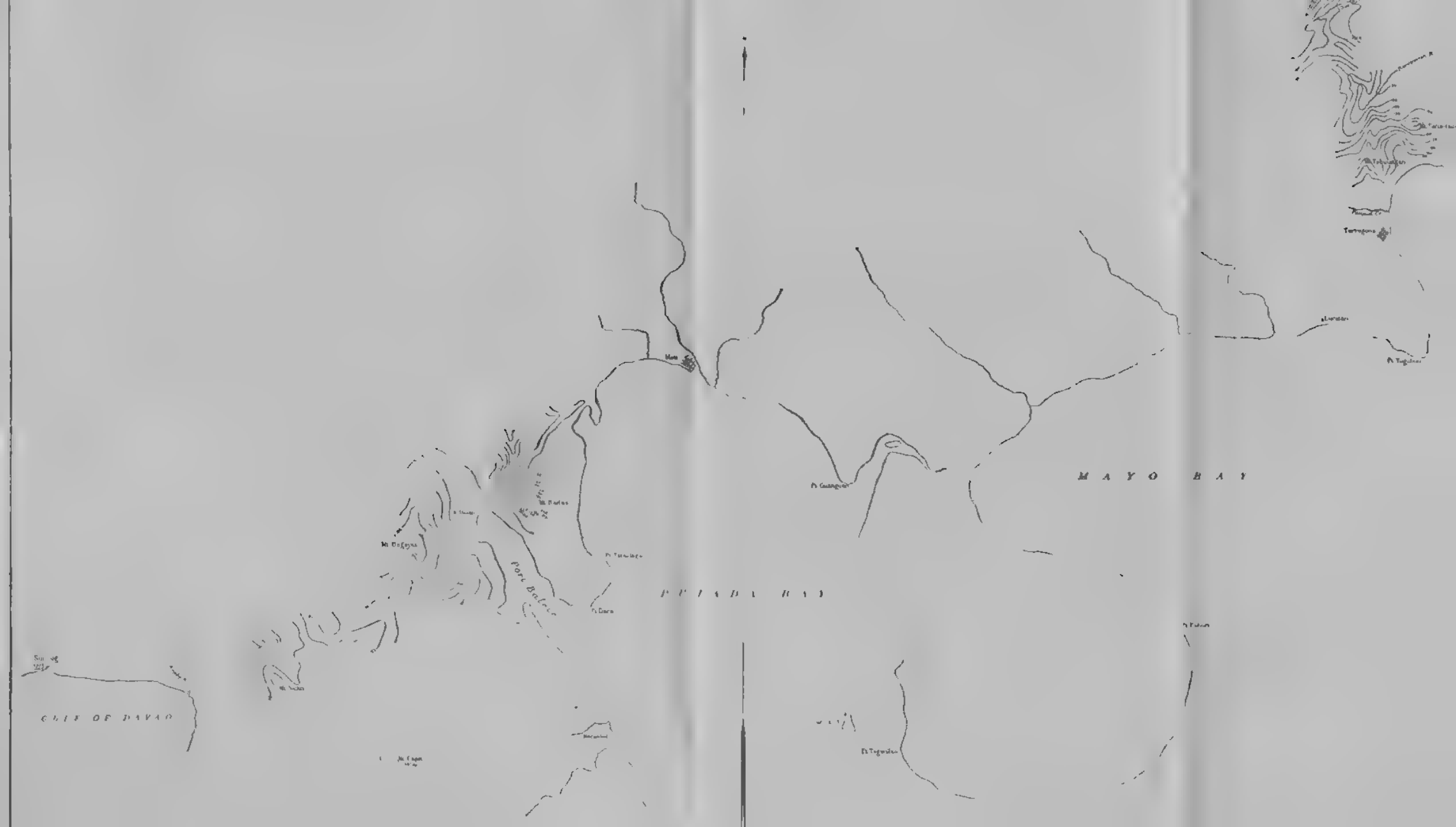
According to a previously arranged plan Mr. Ickis and I separated at this point, Mr. Ickis intending to go with Governor Johnson westward to Bukidnon subprovince, and I to continue northward to the mouth of the Agusan River, and then through the Surigao Peninsula to Placer and Cansuran to investigate the reported gold occurrences at those places. We both left Talacogon on the morning of February 21, I following the river towards its mouth.

An outcrop of argillaceous sandstone, highly fossiliferous, occurs at the junction of the Maasan River with the Agusan. Close approach to the outcrop is very difficult because of the force of the current at this point, but nevertheless a good collection of fossils was made. The bedding was observed to be nearly level, but the dip and strike could not be measured.

Butuan, the capital of Agusan Province, was reached on the afternoon of the following day. Near Butuan the river becomes quite wide. No measurements were taken, but at this point I estimated the velocity of the stream to be about 6 kilometers per hour and the width about 140 meters. The banks, which are very largely cultivated in hemp, consist for the most part of shales lying practically horizontal.

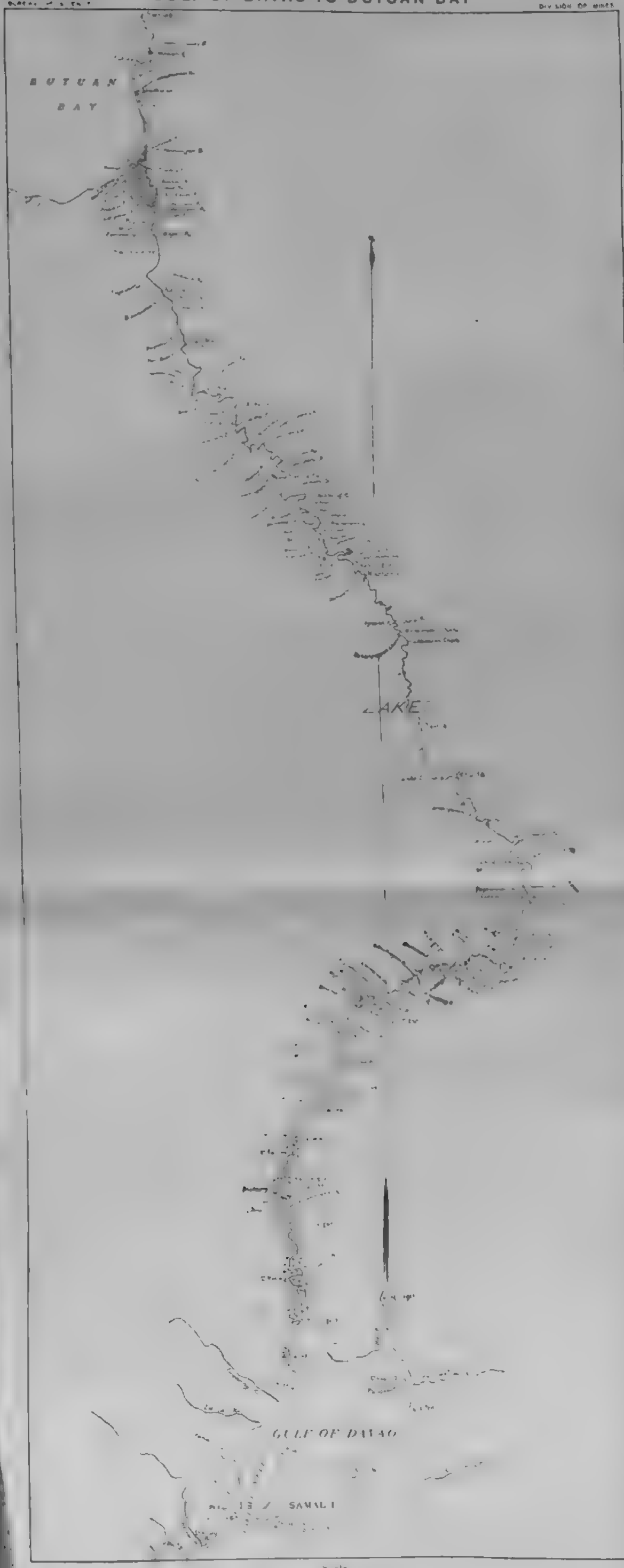
ILLUSTRATIONS.


MAYO BAY
PUJADA BAY
Port Balete
GULF OF DAVAO


MAYO BAY
GULF OF DAVAO

ROUTE MAP.

GULF OF DAVAO TO BUTUAN BAY



Scale

PLATE II


LAKES
GULF OF DAVAO

San Vicente
Amparo
Santa Fe
Guadalupe
LAKES
Veruela
Moncayo
GULF OF DAVAO

THE FISHERY RESOURCES OF THE PHILIPPINE ISLANDS. PART I, COMMERCIAL FISHES.

By ALVIN SEALE.
(*From the Bureau of Science, Manila, P. I.*)

INTRODUCTION.

We have received numerous requests for information regarding the commercial fisheries of the Philippine Islands, especially relating to the different kinds of edible fish and their abundance; the location of fishing banks and the methods of capture. We have also been asked if fishing, entered into as a commercial venture, would be profitable.

It is for the purpose of answering some of these questions that Part I of this series, based on my personal observation in the various islands of the group during the past year and a half, has been prepared. It is hoped that this paper, together with others to follow—namely, Part II, Sponge Fisheries: Part III, Pearl Fisheries; Part IV, Other Marine Products (aside from fishes, pearl oysters, and sponges) will serve to create an interest and help in the development of the rich fishery assets of the Islands.

THE ANCHOVIES.

Family *Engraulidæ*. (Pl. I.)

There are at least four different species of anchovies in the Philippine waters, the most abundant, perhaps, being *Anchovia commersoniana* (Lacépède), called *dilis* in Tagalog, *monamon* in Ilokano, and *anakbat* in Moro. *Anchovia dussumieri* Bleeker, termed *dumpilas* in Tagalog, and *teggui* in Moro is a large species, but less abundant than the *dilis*.

The common anchovy (*dilis*) is found in great numbers along the shores of almost all the islands of the group; it is almost transparent, with very thin, deciduous scales. This species is a delicate little fish of fine flavor and would bring a good price, if put up in attractive form either in oil or spice, or if made into anchovy paste.

THE HERRINGS.

Family *Clupeidæ*. (Pl. II.)

There are about thirteen distinct species of herring represented in the Philippine waters and notwithstanding their rather small size, they are of considerable commercial importance. They abound in immense numbers along the coasts of almost all the islands of the group. Some are more or less migratory, others seem to remain near one place. Large numbers are caught in Manila Bay at all seasons of the year. These represent the forms called *tunsoy* [*Harengula moluccensis* (Bleeker)], *lamban* (*H. longiceps* Bleeker), and *bilis* [*H. gibbosa* (Bleeker)]. The young of all species are termed *siliñasi*. Great numbers are caught in corrals, especially during May and June; they are also taken in the drag-seine. It is not an unusual sight to see large *bancas* loaded to the gunwale with herring being landed at Tondo beach, where the fish are sold to the Chinese to be smoked and dried. The natives in Zamboanga buy large quantities to eat in the fresh state. Any of these sardines would compare favorably with the species put up in oil on the Pacific coast.

During the nine months from January first to September first, 1907, 85,000 pesos worth of canned sardines were imported into the Philippines; this, too, with the Philippine waters swarming with sardines and with an abundance of good sesame oil which could be used for canning purposes, produced in Manila.

THE SILVERSIDES.

Family *Atherinidæ*. (Pl. III.)

The silverside, called *guno* in Tagalog and Moro, and *ti i* in Ilokano, is without doubt the most abundant fish in the Philippines. It is almost impossible to land at any wharf or go ashore on any beach without seeing these little fish in countless numbers. They usually grow to a length of from 10 to 12 centimeters. They have a greenish tint on the back and a bright, silvery band on the sides. There are five or six different species, but they appear so much alike that the natives have not distinguished between them, calling all simply *guno*. The most common species is possibly *Atherina temminckii* (Bleeker).

The *guno* are known as *pescados del rey*, "fishes of the king," among the Spaniards. They are greatly valued as food. The young are termed whitebait. The method of catching is usually by seine or corral. A profitable industry could be built up by preparing these fish in a good sauce, by pickling them with spices, or by drying. An abundant supply

for canning operations could be secured at any of the following places: Manila, Jolo, Zamboanga, Sitanki, Puerto Princesa, and perhaps a dozen other places not yet examined. They abound at all seasons.

THE MACKERELS.

Family *Scombridæ*. (Pl. IV.)

There are at least eight different species of the mackerel family found in the Philippines, all of them good food fishes and of commercial importance. In this family is the *tanguingue*, also called *tangili* or *tangi* (Moro), which is a true Spanish mackerel (*Scomberomorus commersoni* Lacépède). By many people this is regarded as the finest food fish in the Philippine waters. This fish is fairly abundant, and can usually be found in the markets, where it sells from 1 to 4 pesos, Philippine currency (50 cents to 2 dollars United States currency) per fish. At Zamboanga it is nothing unusual to see ten or a dozen of these fish in the market at one time, all of them measuring 90 centimeters or more in length. They are frequently cut up and sold by slices. The major part of the *tanguingue* are caught off shore with a hook and line, a good fishing ground being located off the east coast of Basilan. At Manila they are usually caught in nets. Another Spanish mackerel taken in these waters is *Scomberomorus konam* (Bleeker), which is scarcely distinguishable from the above.

Other important members of the family are the chub mackerels (*alumahan* or *carallus*), *Scomber microlepidotus* Rüppell, and the *hasa-hasa* (*Scomber japonicus* Houttuyn). These fish run in great shoals throughout the Islands, following small fish, upon which they feed. They enter Manila Bay in March and the inhabitants along the shore-line of the bay are kept awake during the nights by the noisy clatter of the fishermen beating with their paddles against the sides of their boats in order to frighten these much desired fish into the nets or hastily constructed corrals.

Still other members of this family represented in these waters are the small bonitoes (*sobad* or *tulingan*) *Gymnosarda pelamis* (Linn.), the great tunnies (also called *sobad*), and the albacore (*Germo alalunga* Bleeker).

All of these fish may be caught with hook and line, in nets or corrals. They are so abundant that it is unusual to make a trip among the Islands without sighting one or more shoals of fish belonging to this family. They are especially common about the Cuyo group and along the shores of Palawan. The market at Zamboanga is usually well stocked with all members of the family. They are with few exceptions fishes of the deep water. The purse-seine in my opinion could be profitably employed in their capture.

THE MUD FISHES.

Family *Ophiocephalidæ*. (Pl. V.)

The mud fishes, *dalag* (*dalak* in Moro), are of considerable importance, especially in the vicinity of Manila where they form a large part of the food of the native population. They are usually sold alive in the markets. In fact, it is their ability to stay alive out of water that attracts attention to them. They are primarily a fresh- or brackish-water fish, and after a rain almost all the little pools by the wayside, as well as the paddies and rivers are well filled with *dalag*. They have the habit of burying themselves in the mud as the ponds dry up and thus of lying dormant until the next rain. They take the hook freely, and it is no uncommon sight to see the natives fishing for them in the rice-fields, or in the most unlikely and recently formed pools. They frequently travel overland in the wet grass and can live for hours out of water. The eggs are deposited in holes in the bank; the mother exercises a care over the young fish.

In India these are regarded as one of the most wholesome fishes and are given to invalids. In Manila they are looked upon more as scavengers and are not much eaten by the Americans. These mud fish are distinctly carnivorous, feeding on small fish, refuse, etc. They are well distributed over the Islands, being found in almost all the lakes and rivers.

THE SNAPPERS.

Family *Lutianidæ*. (Pl. VI.)

There are about twenty different species of this family in the Philippine waters, all of them important as food fishes. They range when full grown from 25 to 90 centimeters in length. They are distributed over the entire group, some running up rivers to the interior lakes to feed. Several of the species are bright red in color and are called red snappers, one of the most abundant being the *bacbaan* [*Lutianus dodecacanthus* (Bleeker)]. Another snapper called the *camangbuhu* (*Lutianus fuscescens* Cuv. et Val.) can usually be found in the markets, especially in Zamboanga. A very important member of the family is the *aleis* (*katumbang* in Moro) (*Lutianus gembra* Bloch et Schn.). These are caught in great numbers in the Naujan River at Batos, Mindoro. The adults weigh from 8 to 20 pounds each. I saw 108 of these fish caught in one-half day at the Batos corral.

The best banks for red snapper fishing seem to be in the vicinity of Zamboanga. *Dapa* and *managat* are other Moro names applied to the red snapper. They are usually caught by hook and line, or in the corral. In Zamboanga a red snapper 35 centimeters long can be bought for 40 centavos.

THE POMPANOS.

Family *Carangidæ*. (Pl. VII.)

There are thirty-six different species of the pompano family known in the Philippines. All of them are valuable commercial fishes. The cavallas (*Caranx*) are the most important branch of the family. They are termed *talakitok* in Tagalog and *daingputi* in Moro. These fish are very abundant in almost all markets. They range from 32 to 36 centimeters in length. As a rule they are caught in corrals.

Another abundant species is the *lison* [*Caranx ignobilis* (Forskål)]. These fish are dried in large numbers by the Moros. The *ballangoan*, termed *cubal-cubal* (*Megalaspis cordyla* Linn.), is another very abundant food fish of fine flavor, belonging to this family. These are reported to reach the length of 155 centimeters; ordinarily those in the market measure about 45 centimeters. They are caught in corrals.

THE SEA BASSES.

Family *Serranidæ*. (Pl. VIII.)

There are thirty-three species of this important family of food fish reported from the Philippines. One of the most familiar is the *apahap* (*tapog* in Moro) [*Lates calcarifer* (Bloch)], one of our largest sea basses. Specimens weighing from 25 to 35 kilos are frequently brought into the market. This fish would afford good sport for local anglers. The largest branch of the family is constituted by the groupers (*Epinephelus*), called *lapo-lapo* in Tagalog, *garopa* in Visayan, and *kukkut* in Moro. (Pl. VIII.) Ordinarily this name is given to the most common species, *Epinephelus merra* Bloch, but it is also applied to at least three others which closely resemble *E. merra*. These fish bring a high price in the Manila market; they are a favorite sea food for many Americans.

Another rather common species is the blue-spotted grouper [*Cephalopholis stigmatopomus* (Richardson)], which is especially abundant in the Zamboanga market. The fishes of this family are usually caught with hook and line in water of considerable depth; sometimes they are taken by net or corral. Gill nets set in about 50 feet of water frequently make good catches.

THE MULLETS.

Family *Mugilidæ*. (Pl. IX.)

There are ten different species of mullet recorded from the Philippines, the most abundant being the *banak* (*Mugil cephalus* Linn.). This fish can always be found in the market and when quite fresh and properly cooked is most delicious. It is very common throughout the entire Archipelago. The mullet is a strictly vegetable feeder, and is usually

found wherever there is an abundance of sea moss. The shallow sea about the Island of Sitanki is a famous feeding ground for this fish.

On the morning of June 29 of this year I witnessed a most astonishing movement of mullet near the Island of Sitanki, Sulu Archipelago. A noise like a great waterfall was heard. Hastening to the beach I saw a vast shoal of the fish coming from the north, keeping quite near the shore; they were leaping along the water in great, flashing waves. The shoal was fully 100 yards wide and 500 yards long; there must have been over a million individuals in it. The fish seemed to be of almost uniform size, about 40 centimeters in length. Nothing stopped them. The natives jumped into the water and killed hundreds with sticks and stones; some were driven ashore, but the shoal passed, leaping, on to the south.

These fish were probably seeking a new feeding ground. They were not breeding, this fact being indicated by the extreme smallness of the ovaries. I should estimate that there were over one hundred thousand pesos' worth of fish in this one lot.

Several species of this family run up the fresh water rivers to the lakes. As many as ten thousand have been caught at one time with a drag-seine near the mouth of the Naujan River in Mindoro. These fish are easily dried and are a good commercial asset.

OTHER COMMERCIAL FISHES.

There are many other fishes in the Islands that are of commercial importance, but lack of space and time will not permit of a detailed description. However, among these we should mention the barracuda, called *pangaloan* or *lambanak* in Moro. This is an abundant and excellent food fish sometimes reaching the length of 1.5 meters. There are also numerous species of porgies, termed *bitilla*, *cutut*, and *guntul* by the natives. These fish are especially abundant about Sitanki, and there they are dried in large numbers. Many members of the grunt family (*Hæmulidæ*) are also seen, these are termed *leffe*, *pasnco*, *bakuku*, and *bagong*;[1] they are especially valuable for salting and drying.

Several members of the gar family (*Belonidæ*), the croakers (*Sciænidæ*), the parrot fishes (*Scaridæ*), the surmullets (*Mullidæ*), the mogarras (*Gerridæ*) and the soldier fishes (*Holocentridæ*) occur. All of these are good food fishes and of commercial importance. A provisional, but incomplete list of the Philippine market-fishes, giving the native, scientific, and English names will be found at the end of this article.

[1] *Bagong* is a general term applied to any small fish mixed with salt and partly dried. Bagong is most commonly eaten in the interior where fresh fish can not be obtained.

THE MILKFISHES.

Family *Chanidæ*. (Pl. X.)

The *awa* or milkfish [*Chanos chanos* (Forskål)], called *bañgos, bañgod, kawag-kawag,* and *tamulocso* by the Filipinos and *bangeltus* by the Moros, is one of the most important commercial fishes in the Islands. It ranges over the entire group, from northern Luzon to Sitanki and is the most abundant fish in the Manila market. Frequently, during protracted rough weather it is the only variety obtainable. It is raised chiefly in the fish ponds at Malabon and at other places near Manila and therefore can be secured at any time regardless of the weather.

This fish is particularly adapted to pond culture, being a vegetable feeder of rapid growth. The *bañgos* superficially resembles the mullet, but can easily be distinguished by the fact that the mullet has two fins on the back, while the *bañgos* has but one. The *bañgos* frequently reaches a length of 1.2 meters and then it is termed *tamulocso*. The eggs are deposited in the sea. The young appear during the months of April, May, June, and July and are called *kawag-kawag*. They are supplied with a yolk-sack which furnishes them with food until they are about 14 millimeters in length. At this age they are to be found in great numbers along the beaches of Zambales, Batangas, Mindoro, Marinduque, and doubtless in numerous other places. Here they are captured by the natives and placed in large earthen jars full of water called *palyok*. They are then conveyed to the fish ponds, frequently a hundred miles distant. (Fig. 1.)

One of the jars, *palyok*, contains about 2,500 young *bañgos*. They sell for from 20 to 25 pesos per *isang laksa* (10,000); about six *laksa* (60,000) are used to stock one pond of 1 hektare. As the fish grow they are thinned out by transfer to other ponds. Thirty-three per cent should reach marketable size. Four months after the transfer the *bañgos* should each be 25 centimeters in length. This size of fish retails for 9 centavos each; in 8 months the young are each 40 centimeters long and bring 20 centavos, while a yearling should measure half a meter and bring from 50 to 60 centavos.

FISH PONDS.[2]

Almost any kind of ground other than a sandy soil will do for a fish pond. It should be near salt water and not beyond the influence of the tide, as the *bañgos* thrive best in brackish water. A complete system should have at least four ponds. These should be so constructed that one equals in area at least that of the other three combined.

[2] I am indebted to Mr. W. D. Carpenter of Malabon for most of the information regarding fish ponds.

Usually the area of the large pond is much greater. The dikes of the small ponds are low, often not 30 centimeters above the water level. These smaller ponds are of about equal size, being usually rectangular and each of about 200 square meters in area. The *palaistaan* are formed by throwing up dikes. The main dikes are large, especially along the banks of the so-called "river" or estero, where mangrove trees frequently are planted for their protection. The water from the estuary is permitted, when the tide is flowing, to enter one of the smaller ponds through a sluice (*pirinza*) usually constructed of masonry with two gates, one of several slides of solid wood for controlling the water and the other of close bamboo palings to prevent the egress of the *bañgos* and the ingress of undesirable tenants such as carnivorous fishes and crabs which burrow into the dikes and cause leakage. Snakes and birds are also evils that have constantly to be guarded against.

This small pond distributes the water supply to the others and is used for capturing the marketable *bañgos*. It is usually separated from the larger pond by a close paling of bamboo around the narrow opening in the partition dike. When it is desired to capture the fish in the largest pond, the paling is removed and a strong current is caused to flow from the smaller pond to the larger. The *bañgos* attracted by the fresh water swim against the current and enter the smaller pond in great numbers, where they are readily captured in a seine. This operation is often accomplished about midnight, so that the fish will be exposed in the Manila markets in the best condition.

The remaining two ponds, or subdivisions of the pond area inclosed within the limits of the boundary dikes, are connected with each other and with the pond which feeds the water by single pipes made of the hollow log of the *luyong* (*Diospyrus nigra* Retz). These tubes are called *palabunbuñgan*, the water and fish being controlled at these openings by a solid wooden plug or a funnel of bamboo strips. The water in these two small ponds is kept at a depth of but a few decimeters, the ponds being used interchangeably for cultivating the food alga (*Oedogonium*) and for developing the *kawagkawag*. (Fig 2.)

FOOD OF THE BAÑGOS

If it is desired to cultivate the food alga (the large pond is originally stocked in the same way), the water is allowed to drain off and the clay is exposed to the full power of the sun. The alga rapidly makes its appearance and a little water is then permitted to cover the bottom. This is gradually increased as the *Oedogonium* develops.

The *Oedogonium* seems to thrive best upon a clean clay (kaolin). If the bottom is covered with a deposit of dark mud and in old ponds where a black, evil-smelling deposit has formed, it is scraped clean with

FIG. 1 THE GUARDIAN OF A FISH POND WITH HIS FAMILY, AND THE JARS OR PALYOK IN WHICH THE FRY ARE TRANSPORTED

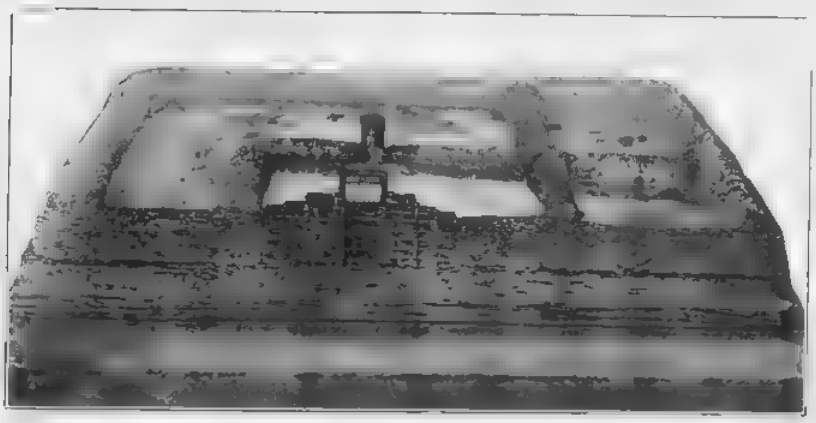


FIG. 2. MODEL OF A BAÑGOS POND SYSTEM CONSTRUCTED BY THE STUDENTS OF THE MALABON INTERMEDIATE SCHOOL

a board. This operation is not necessarily done at any particular season, but whenever the condition demands it. The *Oedogonium* is sometimes purchased and placed in an exhausted pond. A small *banca* load is worth one peso.

A so-called "medicine" for the young fish (apparently used only in small ponds where the water is contaminated by close proximity to houses) is the *Lemna minor* Linn., the floating roots of which are greedily devoured.

When the fry are to be planted in the pond, the water is again allowed to drain off and the alga is partially killed by the hot sun. This, it is claimed, renders the *Oedogonium* soft and fragile for the tiny mouths. Eventually, the young *bañjos* are removed to the great pond where their quantity is largely governed by the supply of the food alga.

The average value of the ponds about Manila Bay is probably 40 centavos per square meter, giving a total of more than 6,000,000 pesos for the pond value alone, which I am convinced is a conservative estimate. I chose one pond which measured 140 by 170 meters as an average of the twenty or more shown on a surveyor's map compiled from data obtained from the owners of the properties.

METHODS OF FISHING.[3]

It has been my privilege to make personal observations of the methods employed in the fisheries of various parts of the world, in the United States, Alaska, New Zealand, Australia, Honolulu, and numerous Pacific Islands, also to some extent in Japan. Some time ago at the instance of the Secretary of the Interior, Mr. Dean C. Worcester and before I assumed my position in the Bureau of Science, I made a more detailed examination of the methods employed in the fisheries of the eastern United States in order to secure the latest information regarding the various kinds of nets and apparatus that could with profit be used to develop the commercial fisheries of the Philippine Islands.

It may not be out of place, therefore, to give brief descriptions of such apparatus as seems to me to be of especial value and short suggestions as to its use.

SEINES.

In the Atlantic fisheries a great many more fish are caught with the various kinds of seines than in any other way. In 1904, the New York fisheries alone captured by this method 214,099,725 pounds of fish, with a value of 826,597 dollars, United States currency.

[3] A full description as to detailed method of construction, size of twine, mesh, hanging of net and methods of using can be obtained by applying to the United States Division of Fisheries.

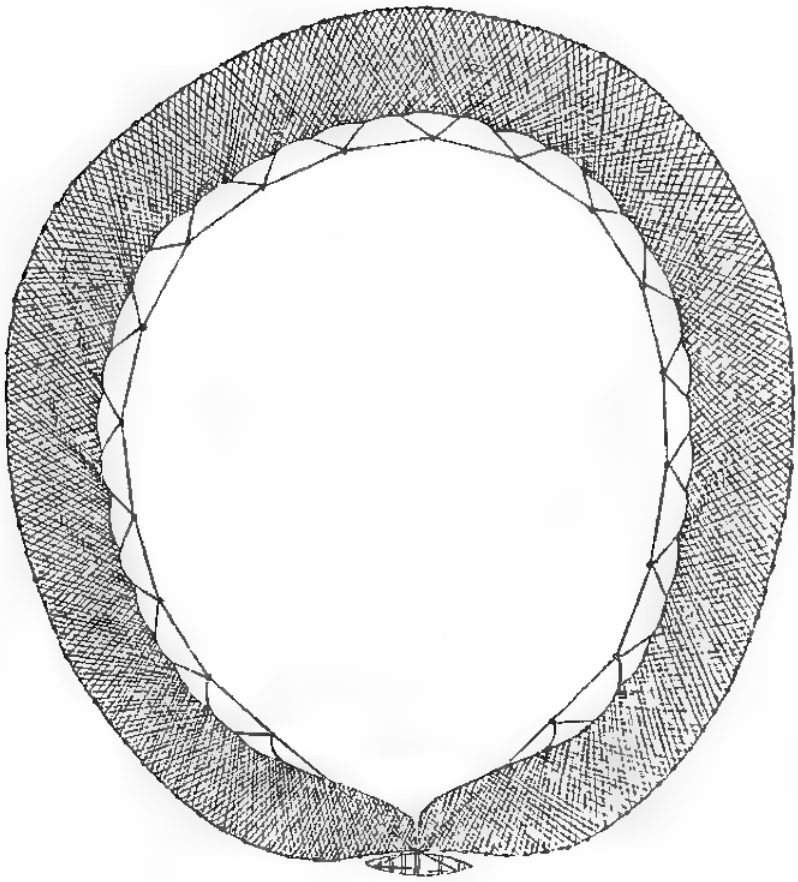


FIG. 3. -THE MACKEREL PURSE SEINE.

Purse seines (fig. 3).—One of the most effective nets used in the American fisheries is the purse seine. An ordinary, deep-water purse seine, such as is employed in the eastern mackerel fishing, is about 200

fathoms in length, and 20 to 25 fathoms in depth when it is hung, it being deeper in the center than at the extreme wings. The boat end of one wing is from 1 to 10 fathoms deep; the other end varies from 7 to 15 fathoms. It is made of three kinds of twine. The bailing-piece, which is a section of the net occupying about 10 to 12 fathoms along the center of the cork line and having about the same depth as length, is made of the stoutest twine. Beneath this, composing the remainder of the middle of the seine and extending to the bottom of the net, is a section knit of twine a size smaller. There is also a band of large twine, 15 meshes in depth, extending along the cork line of the seine on either side of the bailing-piece to the extremity of each wing. The remainder of the net is made of lighter twine. The lead and cork line are in the same position as in ordinary seines. This net is operated by a series of pursing ropes and rings, by means of which the bottom of the seine is drawn up and closed. Formerly this net was taken out in fishing schooners and when a shoal of fish was seen, it was placed in a seining boat, the shoal was surrounded by the net, the latter at once pursed, the vessel then brought alongside and the fish dipped out. Now, in some cases, the net is carried on a revolving table at the stern of a small steam-vessel or launch, and the surrounding of the shoal and pursing of the net is all done quickly and efficiently by steam. Frequently more fish are taken in this way than can be used in one day. In this event, they are put into a "spiller" or pocket, which is a form of live box made of stout, coarse twine, and is attached to the side of the vessel, where it is kept in position by wooden poles or outriggers extending 15 feet from the vessel's side. This apparatus is nothing more than a big net bag 36 feet long, 15 feet wide, and 30 feet deep. This size will hold 200 barrels of live mackerel, but of course the spiller may be constructed of any dimensions. The purse net could probably be used with profit in catching the various kinds of mackerel (*masanguí*, etc.) found in Philippine waters.

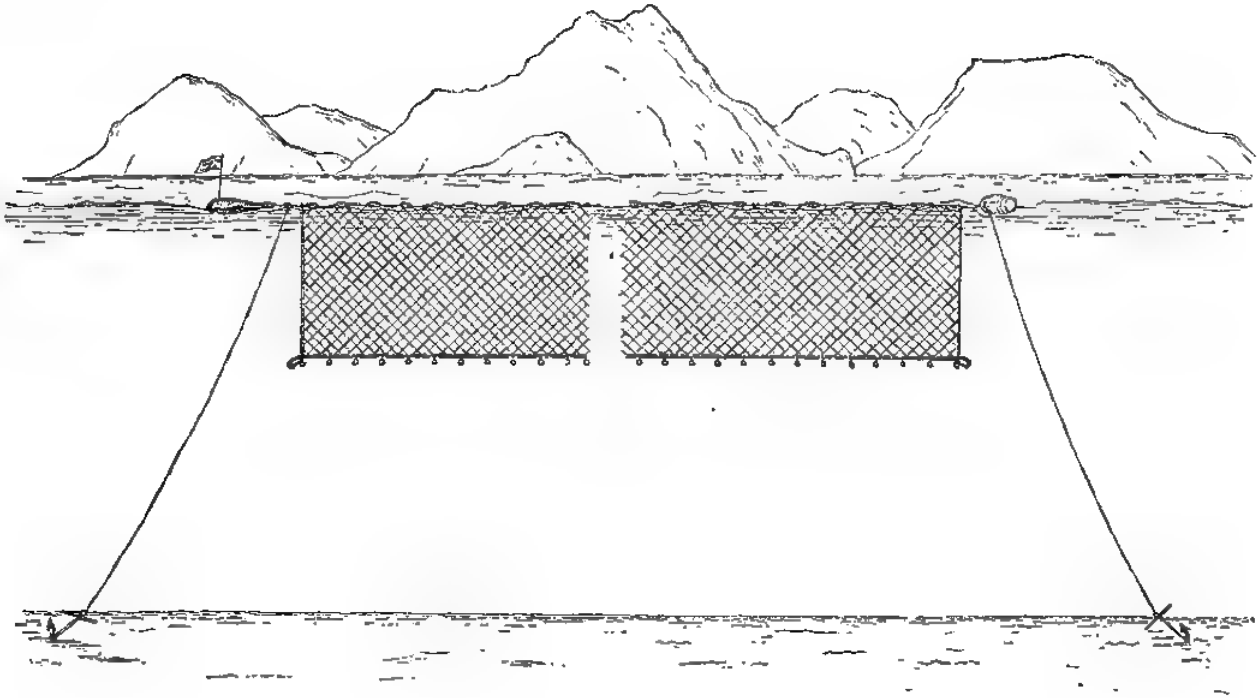


FIG. 4.—SHOWING METHOD OF SETTING GILL NETS AT THE SURFACE.

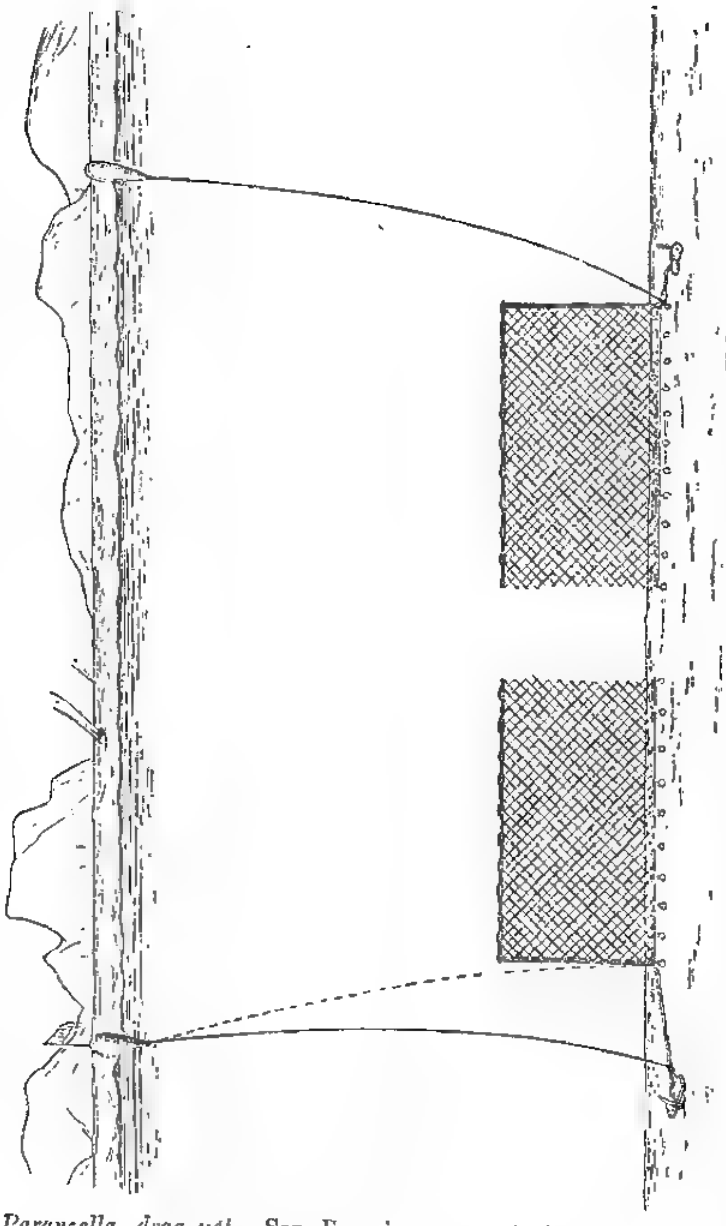


FIG. 5.—SHOWING METHOD OF SETTING GILL NETS AT THE BOTTOM.

Paranzella, drag net.—San Francisco seems to be the only place in the United States where this form of net is used. The nets are from 50 to 75 fathoms in length, with short wings and a long bag and are from 6 to 8 feet high. A small steam-launch is used at each end and the net is dragged along the bottom. The meshes of the wings of the net are 1¼ inches wide, the lower side which drags the bottom is made of coarse twine with a mesh from 2 to 4 inches in width. Frequently, a

tug load of fish is secured at one haul. This net could only be used on smooth, sandy bottom free from coral, and employed chiefly to catch flatfish, flounders, etc.

Pound nets.—Many kinds of pound nets are used in the American fisheries, but as this manner of fishing is well known and used in the Philippines in the various forms of corrals or *baclods* no descriptions are necessary Notwithstanding the expense of building, it is one of the most successful methods of fishing as is attested by the hundreds of corrals in the Islands.

Fyke nets.—These nets, which are usually of small size and consequently not very expensive, could be profitably used for the capture of the various species of catfishes, *dalags, martinicos,* etc.

OTHER METHODS OF FISHING.

Trawl lines.—While trawl-line fishing was formerly employed almost exclusively for catching codfish, it is now used to capture a great many varieties. At Monterey, California, I noticed the trawl lines being operated with good success to catch several kinds of fish, such as rock-cod, etc. They might be used with profit in the Philippines for such fish as the groupers (*Serranidæ*), the *mulmul,* and others which take the hook freely at the bottom. They are especially effective in taking eels.

The trawl line consists of a strong ground-line 300 fathoms in length, to which is fastened at intervals of one fathom a line 3 feet long to which a hook is attached. The hooks are baited and the ground-line anchored at the bottom with a buoy to indicate its location. A line for pulling it up is attached to it.

Live-cars.—Next to improving the method of catching the fish, the most important thing is to devise means by which they may be kept alive until they are wanted by the consumer. To this end the live-car is brought into requisition in several places, especially in tropical countries. This device is a very simple contrivance consisting of a square or quadrangular box constructed of slats placed close enough together to keep the fish in, but far enough apart to allow of a free circulation of water. The cars are immersed in the water and the fish are kept inside until they are wanted by the purchaser. At Key West the fishing schooners are now usually provided with wells in which the water is kept circulating, and in this way the fishermen are able to keep the fish alive. The fishing boats at Honolulu have wells with perforated sides through which the water circulates freely. At this place live boxes or cars are in common use. Some of these are very large and are kept anchored close to the fish market. The purchaser selects his fish from the wharf, it is then dipped out of the live-box and delivered. Some modification of this plan could be adopted in the Philippines, but it is only feasible where the market is near salt water.

LOCATION OF FISHING BANKS.

The following fishing areas or banks seem to be the most prolific so far as I have investigated and they would well repay working

The vicinity of Sitanki is practically all a fishing bank, being well supplied with organic life upon which fishes feed. The trade at this place is now in the hands of the Chinese. There are numerous good fishing banks in the vicinity of Zamboanga, especially off San Ramon and along the Basilan coast; one a few miles south of Cagayan Sulu and a number along the coast of Palawan. Some very prolific banks exist near the Cuyo Islands and close to Masbate and Cebu. The bank which chiefly supplies the Manila market is located near Corregidor Island.

Doubtless numerous other fishing banks can be found; in fact, wherever we encounter a comparatively shallow area of from 5 to 20 fathoms, with plenty of sea moss and rich in small marine organism, we may be assured of finding it well stocked with fishes. Sooner or later these places will all be accurately located and worked. What is needed is men of experience who will give the industry their entire attention; such people will win profitable results.

THE CHIEF FOOD FISHES IN PHILIPPINE WATERS.

Filipino.	Moro.	English	Scientific.
Agaut		Grunts	*Serranidæ*
Aligasin		Mullet	*Mugilidæ*
Alumahan, matasa	Salay salay	Pompano	*Scomber macrolepidotus* Ruppell.
Ayungin	Lagohot	Grunt	*Pelidnoma basta* (Bloch).
Baga-baga	Bungu-bungu	Soldier fish	*Myripristis murdjan* (Forskål).
Bagaong, barongan	Bigaong	Grunt	*Therapon jarbua* (Forskål).
Bakoko	Gaud-gaud	Porgy	*Sparus calamara* Russell.
Balang		Flying fish	Family *Exocœtidæ*.
Balila		Band fish	Family *Trichiuridæ*.
Banak, lumitog	Banak	Mullet	*Mugil cephalus* Linn.
Bangos, banglot	Bangollus	Milkfish	*Chanos chanos* (Forskål).
Barangan	Tamban	Herring	*Hisha hevenii* (Bleeker).
Barikudo, bahayo	Lamlanak	Barracuda	*Sphyræna langsar* Bleeker
Bia		Gobies	Family *Gobiidæ*.
Bia, bunog	Tamangka	Goby	*Gnathalpis deltoides* (Seale)
Biang-itum	Tighasbay	Goby	*Gnesiogobius bicellatus* (Cuv et Val.).
Biang-puti, balla	Kapalo	Goby	*Gnesiogobius guavus* (Ham. Buch.).
Bidbid		Ten pounder	*Elops saurus* Linnæus.
Bitilla, apahap, biquilla	Balaba	Drum	*Umbrina russelli* Cuv. et Val.
Bonito, tangi	Solad	Oceanic bonito	*Gymnosarda pelamis* (Linn.).
Buan-buan		Tarpon	*Megalops cyprinoides* Broussonet.
Buguing		Half beaks	Family *Exocœtidæ*.
Buligay-ligay, lunog	Tamanka	Goby	*Rhinogobius oryzarus* Jordan et Seale.
Buteteng-saguing		Puffers	*Spheroides lunaris* Bloch et Schn.

THE CHIEF FOOD FISHES IN PHILIPPINE WATERS—continued.

Filipino.	Moro.	English.	Scientific.
Butete	Tingga tingga	Puffers	Family *Tetraodontidæ*.
Cabasi	Tatik	Bastard shad	*Anodontostoma chacunda* Ham.-Buc.
Balag	Dalak	Mud fish	*Ophiocephalus striatus* Bloch.
Dungat, bagsang	Totok	Wharf fish	*Priopis urotænia* Bleeker.
Dilis, Monamon	Anakbat	Anchovy	*Anchovia commersoniana* (Lacépède).
Dumpilas	Tatik	Anchovy	*Anchovia dussumieri* Bleeker.
Espada		Band fish	Family *Trichiuridæ*.
Guno, tid	Guno'e	Silverside	*Atherina temminckii* (Bleeker).
Garropa		Grouper	Family *Serranidæ*.
Hasa-hasa		Japan mackerel	*Scomber japonicus* Houttuyn.
Hito, paltat		Catfish	*Clarias magur* (Ham.-Buc.).
Igat, quiuet	Tagulbos	Rice-paddy eel	*Jenkinsella nectura* Jordan
Kabasi	Tatik	Basling shads	Family *Dorosomatidæ*.
Kabayo-kabayohan	Undok	Sea horse	Genus *Gasterotokeus*.
Kalaso, dalda-ag	Tigbasbay	Lizard fish	*Saurida argyrophanes* Rich.
Kanduli kanduli	Gagu'e	Catfish	*Nelma nasuta* (Bleeker).
Kapalo, bunog	Kapalo	Goby	*Illana cæcabel* Smith et Seale.
Kilang		Butter fish	Family *Ephippidæ*.
Lapo-lapo, garopa	Kukkut	Groupers	*Epinephelus merra* Bloch.
Lawin, bolador	Bengke	Flying fish	*Parexocetus mento* (Cuv. et Val.).
Malakapas, ieoran	Porok	Mojarritas	*Xystæma kapas* (Bleeker).
Mamali		Thread fin	Family *Polynemidæ*.
Martinico, amaro	Pilit	Climbing perch	*Anabas scandens* Daudorff.
Moong, mamong	Bengke	Cardinal fishes	*Amia chrysopoma* (Bleeker).
Mumul, molmol	Lammon	Wrasse fishes	*Chærops unimaculatus* Cartier
Mulmul, Molmol	Ogos	Parrot fish	*Callyodon latifasciatus* Seale et Bean.
Pagui-, pagui	Kampso	Sting ray	*Dasyatis kuhli* (Müller et Henle).
Pating, iyo	Kaitan	Shark	*Sedhiotus walbechaii* (Bleeker).
Sakutin		Red fish	Family *Trascanthiidæ*.
Samaral, malaga	Bel-long	Siganno	*Siganus vermiculatus* Cuv. et Val.
Sapsap	Sapsap	Slip mouths	*Leognathus splendens* (Cuv.).
Saramullete, banaki	Mangentut	Goat fish	*Upeneus sulphureus* Cuv. et Val.
Sitiñasi, bilis	Pinatay	Herring, young	*Harengula* sp.
Silin, sirin	Celo	Gar fish	*Tylosurus gigas* (Temminck et Schlegel).
Sumbilang, ito	Bakl'e	Catfish	*Plotosus anguillaris* (Bloch).
Sunog, uram-uram	Kamang	Flatheads	*Platycephalus insidiator* (Forskål)
Talakitok		Carallas	Family *Carangidæ*.
Talakitok, tarukotokan	Anak'bung	Carallas	*Caranx sexfasciatus* Quoy et Gaimard.
Talang talang, saleng-saleng.	Tangtang	Slipery dick	*Scomberoides tolo-parah* (Rüppell).
Tanguingue	Tangi	Spanish mackerel.	*Scomber morus commersoni* Lacépède.
Tulis, tulisan	Tamban	Sardine	*Sardinella clupeoides* (Bleeker).
Tunsoy, Bilis	Tamban	Herring	*Harengula moluccensis* (Bleeker).

PLATE I. DILIS, ANCHOVY.
Dichoma commersonianum (Lacépède)

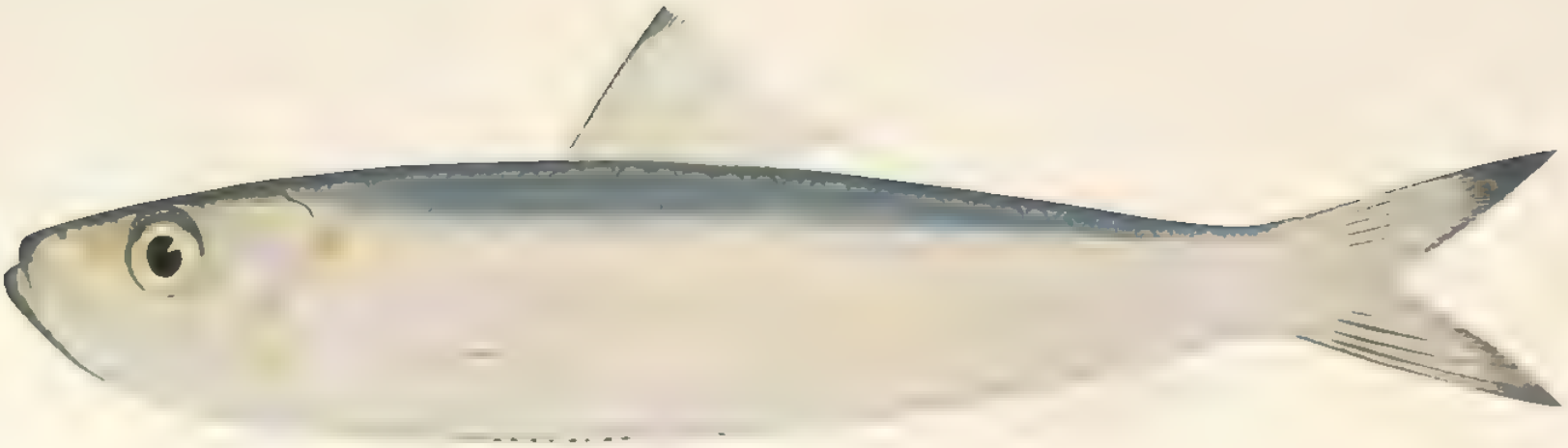


PLATE II. SILIÑIASI, HERRING.
Harengula moluccensis (Bleeker).

PLATE III GUNOC, SILVERSIDE

Atherina forskali Rüpp. f.

PLATE IV TANJUINGUE, SPANISH MACKEREL

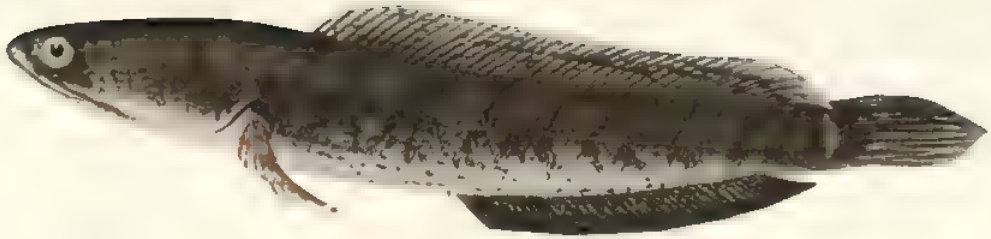


PLATE V. DALAG, MUDFISH

Family *Ophiocephalidæ*

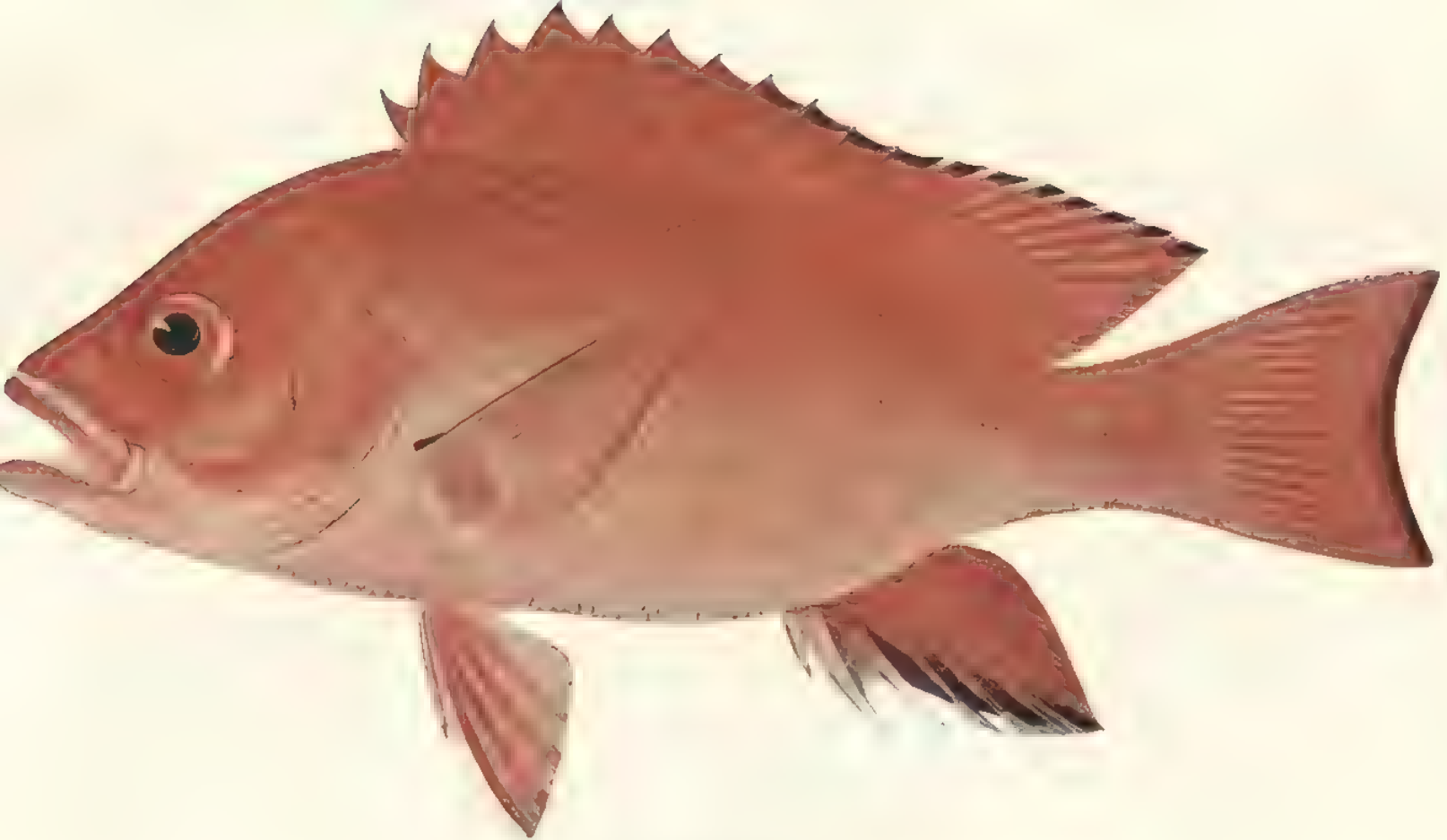


PLATE VI. MAYAMAYA, RED SNAPPER.

Lutianus dodecacanthus Bleeker.

Plate VII. TALAKITOK, POMPANO

Caranx ajax Forskål

PLATE VIII. LAPO-LAPO, GROUPER

Epinephelus megachir (Richardson)

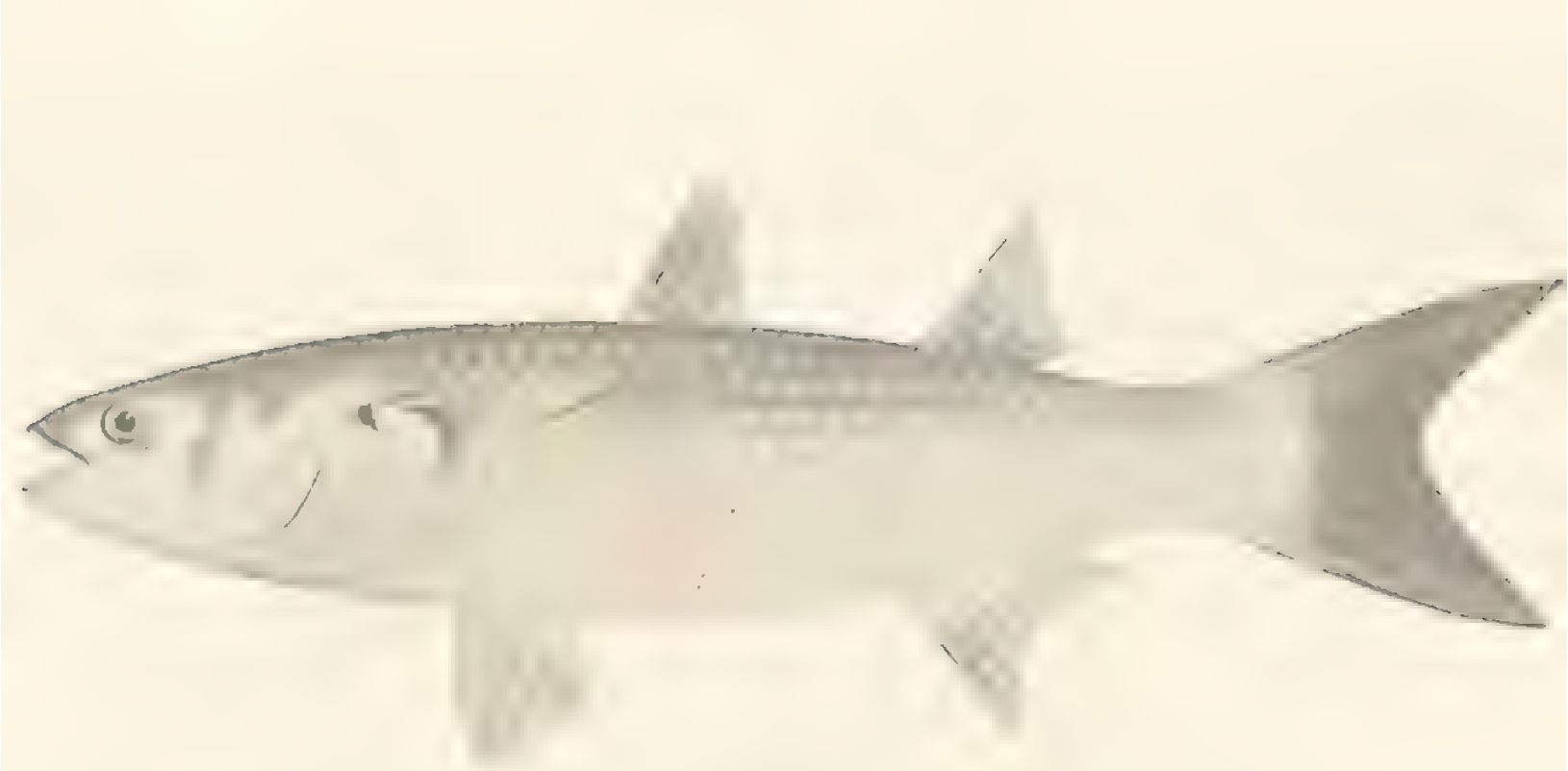


PLATE IX. BANAK MULLET.

Mugil cephalus Cuv. et

PLATE X. BAÑGOS, MILKFISH.

Chanos chanos Forskål.

EDITORIAL.

TYPHOONS, COCONUTS, AND BEETLES.

Reports are frequently seen of the destruction of considerable numbers of coconut trees by typhoons. As the chief coconut-producing districts of the Philippines are subject to typhoons, and as the tree thrives in exposed situations, I have been interested in seeing what damage is actually done to it by storms. During several years of attention to this subject, I have yet to see the first sound trunk broken by the wind, or the first tree uprooted, unless its root system had already been exposed or weakened. Typhoons doubtless do break sound coconut trees; but it must be rarely indeed. Trunks extensively channeled by beetles are comparatively often broken; and trees the roots of which have been laid bare by washing away the soil, or which grow in ground too wet to permit the healthy growth of the roots, are often overturned. However, the loss of such trees is not a serious matter.

Very severe storms weaken the trees and set them back maternally by breaking the leaves; and they sometimes destroy a considerable part of the crop in sight by throwing down immature nuts, even the very young ones, but vigorous trees entirely outgrow such injury within a year.

However, in places where beetles, especially coconut weevils (red beetles), *Rhynchophorus ferrugineus* Fabr., are a serious pest, violent storms furnish conditions for their entrance and multiplication and in this way do damage which is neither insignificant nor transient. This weevil is ordinarily unable to penetrate the thick and dense fibrous protection made by the imbricate leaf-bases around the upper end of the stem, and can only attack trees to which the rhinoceros beetle (*uang*), *Oryctes rhinoceros* Linn., has already done some injury. The breaking of the petioles, the tearing of the fibrous bases and the occasional split cracks of the trunks, caused by severe storms, make it possible for the weevils to enter many trees and so to multiply rapidly: once in the tree, this pest is decidedly more dangerous than the *uang*.

Mr. E. E. Green, government entomologist of Ceylon, reports a remarkable increase in the number of red beetles after a cyclone which visited the Batticaloa district in March, 1907. The beetles had been systematically collected since 1903, the number decreasing steadily: the record for various plantations being complete by months. In one case

where 199 had been caught in May and June of 1906, 1,906 were captured in the same months of 1907. In another instance, the increase in the same months was from 138 in 1906 to 3,889 in 1907. This increase was almost entirely in the number of beetles extracted from the standing trees. Mr. Green says:

"I have found nearly fully grown larvæ of the beetle (*Rhynchophorus*) in trees under conditions that indicate that they must have developed within a period of six weeks. It seems possible that the insect may reach maturity in from eight to ten weeks' time."

The only way in which such serious outbreaks, following typhoons, can be prevented, is by the suppression of the beetles at all times. This is impossible without such unity of action as is practicable only when demanded by law. As beetles are a pest throughout the Islands, legislation by the Insular Government is needed. The Provinces of La Laguna and Tayabas have passed ordinances against a local coconut pest, the bud rot, and have very promptly reduced it to comparative harmlessness, but single provinces can not deal effectively with beetles. The Straits Settlements, the Federated Malay States, and Ceylon have for years had laws aimed at the suppression of beetles, and their value is well proved. Coconut products are second only to abacá in the value of exports of the Philippines. The beetles are probably at this time our most dangerous and most destructive agricultural pest. It is hoped that the Legislature during its coming session will pass an Act providing for their suppression.

E. B. COPELAND.

CUTCH.

Cutch, a product of the heartwood of *Acacia catechu* Willd., has been known from India and Burma for many years. It is used as a dye and for tanning. Considerable quantities were exported to Europe for use in dyeing cotton goods. The supply was not entirely uniform or reliable because of the scattered manner of growth of the trees and the nomadic habits of the tribes that collected the cutch. When it was discovered [illegible] several of the different varieties of mangrove trees had bark which would furnish excellent dye and tanning material, they began to be considered as to the possibility of their furnishing a cutch to take the place of the Indian article.

It was found to be a comparatively simple matter to prepare the mangrove bark extract and the supply of mangroves was very great. Several companies started preparing the extract in the extensive swamps of Borneo; it succeeded in the market and quickly superseded the Indian cutch to such an extent that this term is now used mainly with reference to the mangrove extract.

When the use of aniline dyes became common, it was found that the Bismarck browns would furnish a cheaper and more easily handled dye than cutch; consequently, the latter gradually ceased to be used as a dye. It still had a very large field or usefulness as a tanning extract and the manufacturers felt very little concern at this loss of importance as a dye.

The original cutch was a low grade product and was admitted to the United States free of duty. The mangrove extract was of a better quality and it was decided to place a tariff on it. By Treasury Decision No. 27197, of March 9, 1906, it was declared that mangrove extract should no longer be allowed free entry as cutch, but should be dutiable under paragraph 22 of the Customs Act of 1897.

Cutch, as a crude and low grade extract, could not pay this duty and leave any profit for the manufacturer; consequently, the oldest of the firms in Borneo found it advisable to retire from business. There are still four companies making cutch in Borneo, but they are shipping scarcely any of it to the United States because the duty takes away nearly all of the profits.

The principal species of mangroves from which the bark extract is made are *Rhizophora mucronata* Lamk., *R. conjugata* L., *Bruguiera gymnorrhiza* Lamk., *B. eriopetala* W. & A., and *Ceriops roxburghiana* Arn. Other species are also used; but these occur in the greatest quantity and are of the widest distribution. All of these are found in abundance in the Philippines.

F. W. FOXWORTHY.

COAL IN THE CAGAYAN VALLEY.

Coal has long been known to exist in the Cagayan Valley in the vicinity of Alcalá, and last September Mr. R. N. Clark and I, both of the division of mines, Bureau of Science, had the opportunity of visiting several of the outcrops.

The first was near Baggao, a small town about 10 kilometers up the Paret River, a stream joining the Cagayan at Alcalá. The coal outcrops in a small brook called the Wawing, about 3 kilometers north of the town. Here the seam is about a meter in thickness. Above the coal is a layer of clay gradually changing to a coarse sandstone; below is a sandy clay. This coal was worked for a short time during the Spanish régime and a large open-cut made, but after the death of the owner the concession was allowed to lapse.

About 2 kilometers west of this outcrop, coal occurs in the bed of a small stream flowing north. It was not possible to gauge the thickness of the seam here, but in all probability it is no greater than the first one

we visited. There is said to be better coal farther up the Paret River in the San José Valley, near the barrio of Taytay, but the swollen condition of the river prevented a visit. Coal is also reported from the village of Tenblique near Baggao, on the south side of the Paret.

The following description of coal outcrops in the vicinity of Nasiping is from the report of Mr. R. N. Clark:

"The village of Nasiping, a barrio of Gattaran, is situated on the northeast bank of the Cagayan River and about 2 kilometers above the junction of the Chico River. The town was formerly a municipality and in a rice-growing district. However, at present the rice fields are deserted and covered with a rank growth of cogon grass and guava bushes, all the inhabitants with the exception of a few families having migrated to the more profitable tobacco-raising districts. Those still living in this place are so poor that it is seldom possible to obtain from them provisions of any kind.

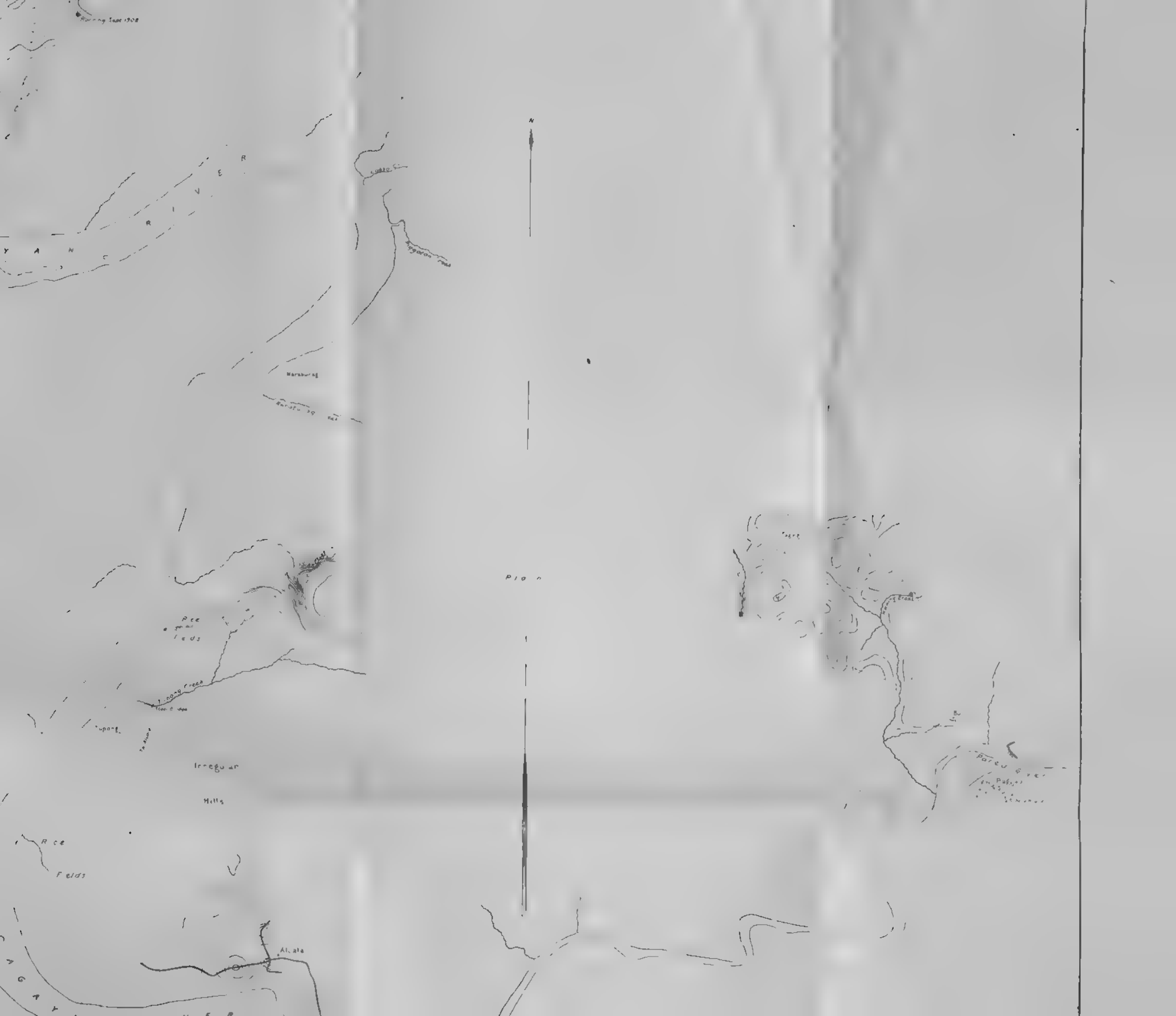
"To the northeast of Nasiping stretches a range of low, grass-covered hills among which the coal beds are located. The first bed visited lies N. 35° E. of Nasiping and 2.5 kilometers distant; the elevation by aneroid being 93 meters above the Cagayan River. This bed was on fire at the time of my visit, probably having caught from grass fires. It was burning at two places and also on the upper or north side, and an area oblong in shape and about 800 square meters in extent had already been consumed. The surface is barren, baked clay, lying 0.5 meter below the level of the surrounding, unburned area. The fumes arising from the burning coal are strong in sulphurous gas and some sulphur and alum occur mixed with the clay overlying the deposit. Old residents of Nasiping say that many years ago a large volcano existed in the nearby hills to the east. The story has been passed down for several generations, so the exact location of the reported volcano is not known. As no evidences of former volcanic activity were found in the region it is probable that this story has its origin in a former fire in the coal.

"The only other outcrop visited in this vicinity was exposed in the bed of a small estero 500 meters northwest of the burning bed. Several years ago a Mr. Anderson took out several tons of coal from near this outcrop. It was burned on the steamer *Chipaga*, but it is reported that it was found necessary to mix it with foreign coal to secure satisfactory results. At the time of my visit, these workings were caved in and overgrown with tall grass, so I was unable to observe the thickness of the seam or examine the adjacent rock formation. The outcrop in the nearby stream had a thickness of nearly a meter. No solid formation was encountered for a distance of 50 meters in the stream above this outcrop. There and above, alternating beds of shale and clay were found.

"Through the courtesy of Mr. H. J. Brown, I was able to secure a guide who took me to an outcrop 2.2 kilometers to the northeast of the steel bridge across the Tupong Creek and about 4 kilometers north of Alcalá. This outcrop was found in the bed of Tarny Creek, barrio of Maasin, and 45 meters above the Cagayan River. The coal at this place strikes north-northeast and dips 30° to the west-northwest. Directly above is a layer of black clay and below a lighter colored variety. A coarse sandstone occurs 50 meters downstream. The coal seam is but 0.5 meter in thickness, and the natives say that an outcrop, only 15 centimeters thick was formerly exposed a kilometer to the south and on the south side of the main ridge."

ILLUSTRATION.

PLATE I. Coal outcrops in the vicinity of Alcalá, Cagayan Province, P. I.


Burning Spring 1908
Marsburg
Rice Fields
Irregular Hills
Rice Fields
Alcala

BOOK NOTICES.

General Physics. An Elementary Text-book for Colleges. By Henry Crew, Ph. D Pp., xii+522. Price, $2.75 net. New York: The Macmillan Company, 1908.

The Elements of Physics. A College Text Book. By Edward L. Nichols and William S. Franklin. In three volumes: Vol. II, Electricity and Magnetism. Cloth. Pp., viii + 522. Price, $1 50 net. New York: The Macmillan Company, 1907.

ERRATA.

Page 41, **Diospyrus canomoi** should read **Diospyros canomoi A. DC.**
Page 42, **Antiaris toxicara** should read **Antiaris toxicaria Lesch.**
Page 44, **Sunasia Amori Blanco** should read **Lunasia amara Blanco.**
Page 70, Table II, No. 22, **0.827** should read **0.927.**
Page 86, Under substances used for synthesis of ylang-ylang oil, add **linaloöl** and **geraniol.**
Page 140, Table VII, Calcium oxide should read **61.94%** from bag; **62.04%** from can instead of **63.44%** and **63.32%.**
Page 250, Under Filaria mosquito, **arribalzaga** should read **Arribalzaga.**
Page 405, **Volcanic fuel** should read **volcanic tuff.**

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[New generic and specific names are printed in *heavy-faced* type.]

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